



Atty. Docket No. ADV12 P-300A  
Express Mail No. EV432932097US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Art Unit : 1761  
Examiner : Thuy Tran Lien  
Applicants : Cheree L. B. Stevens et al.  
Appln. No. : 09/778,470  
Filing Date : February 7, 2001  
Confirmation No. : 4695  
For : **WATER-DISPERSIBLE COATING COMPOSITION  
FOR FRIED FOODS AND THE LIKE**

SECOND DECLARATION OF JOHN STEVENS

I, John Stevens, do hereby declare as follows:

1. I am the Vice President for Research and Development for Advanced Food Technologies, assignee of the present patent application. I graduated from Cornell University with a Food Science Degree in 1970. I have had over 30 years experience in the food science industry. I have had extensive experience specifically in the food coatings area for 14 years, since 1989.

2. From 1989 to 1991, I was the Research and Development Manager for Universal Foods Corporation, where I directed coated french fry developments which resulted in 60 million dollars in additional annual sales for the company. I developed the first clear coat French fry, now having estimated market sales of over 1 billion pounds per year.

3. From 1991 to 1994, I was Director of Technical Services for McCain Foods, Inc. I directed all of the potato food coatings research for McCain Foods, Inc., including the development of marketed coatings.

4. From 1994-1996, I was the Research Manager for Miles Willard Company, directing all frozen and non-snack dehydrated potato development, including the development of a patented clear coat French fry product.

5. From 1996-1999, I was the Director of Northwest Region Technical Services for Newly Weds Foods, Inc. I established, staffed and directed all formula, process,

specification, and commercialization of seasoned and clear coat French fry batters for all French fry processors and chain accounts throughout the United States. I developed and commercialized a signature clear coat french fry for a major processor and for a major national chain account.

6. From 1999 to date, I have served as the Vice President of Research and Development for Advanced Food Technologies. A copy of my resume is attached hereto as Exhibit 1.

7. "Clear coat" compositions, which are nomenclatured as such by the french fry coating industry because they result in a substantially clear coating on a substrate upon thermal processing of the coating on the substrate, are at least mildly agitated while being held in a wet slurry batching/holding container.

8. Agitation is utilized to help ensure even dispersement of the dry batter solids within the slurry.

9. Ungelatinized starch is utilized to help ensure a relatively constant viscosity, which in turn helps maintain relatively constant wet batter pick up on the finished products and thereby a relatively constant coating.

10. If a pregelatinized starch is utilized, even the mild agitation used to keep the dry batter in suspension will continually lower the viscosity due to the deterioration of the starch. This therefore requires the addition of more dry solids to maintain viscosity, which usually results in altered or inconsistent coatings being applied to the substrate being coated due to the difficulty of adding the appropriate amounts of dry solids while agitation is in process. Even if viscosity is somehow able to be maintained by constantly adding more dry solids, the finished product's color, flavor, and texture attributes would constantly be altered due to the increased amounts of dry batter solids.

11. All statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true, and further, these statements are made with the knowledge that willful false statements and the like are punishable by fine or

imprisonment, or both, under 18 U.S.C. § 1001, and that such willful false statements may jeopardize the validity of this application or any patent issued thereon.

April 19, 2005  
Date

John F. Stevens  
John Stevens



Atty. Docket No. ADV12 P-300A  
Express Mail No. EV238420590US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Art Unit : 1761  
Examiner : Lien Thuy Tran  
Applicants : Cheree L. B. Stevens et al.  
Appln. No. : 09/778,470  
Filing Date : February 7, 2001  
Confirmation No. : 4695  
For : WATER-DISPERSIBLE COATING COMPOSITION  
FOR FRIED FOODS AND THE LIKE

DECLARATION OF JOHN STEVENS

I, John Stevens, do hereby declare as follows:

1. I am the Vice President for Research and Development for Advanced Food Technologies, assignee of the present patent application. I graduated from Cornell University with a Food Science Degree in 1970. I have had over 30 years experience in the food science industry. I have had extensive experience specifically in the food coatings area for 14 years, since 1989.
2. From 1989 to 1991, I was the Research and Development Manager for Universal Foods Corporation, where I directed coated french fry developments which resulted in 60 million dollars in additional annual sales for the company. I developed the first clear coat french fry, now having estimated markets sales of over 1 billion pounds per year.
3. From 1991 to 1994, I conducted food coatings research for McCain Foods, Inc.
4. From 1994-1996, I was the Research Manager for Miles Willard Company, directing all frozen and non-snack dehydrated potato development, including the development of a patented clear coat french fry product.
5. From 1996-1999, I was the Director of Northwest Region Technical Services for Newly Weds Foods, Inc. I established, staffed and directed all formula, process, specification, and commercialization of seasoned and clear coat french fry batters for all french fry processors and chain accounts throughout the United States. I developed and



commercialized a signature clear coat french fry for a major processor and for a major national chain account.

6. From 1999 to date, I have served as the Vice President of Research and Development for Advanced Food Technologies. A copy of my resume is attached hereto as Exhibit 1.

7. Cheree Stevens, the inventor of the above-identified patent application, is my spouse, and is the Director of Technical Services for Advanced Food Technologies, Inc. Cheree Stevens also has considerable experience in food sciences, having obtained her degree in Food Technology from the South Glamorgan Institute, University of Cardiff, Wales, UK in 1984. She has devoted her professional career to food sciences, and has specifically focused on food coatings since becoming employed by Advanced Food Technologies in 1999.

8. Although not a patent attorney, I am familiar with patents. I am a named inventor on patents, including the Stevens et al. United States Patent 5,965,189 identified in the "Background of the Invention" of the present application. I understand that in order to be patentable, an invention must be new. I also understand that the subject matter to be protected by the patent must not have been obvious to one of ordinary skill in the art at the time the invention was made.

9. I understand from patent counsel that the first step in considering whether or not an invention is patentable is to determine the scope and content of the prior art, and that this involves determining what the prior art would have taught to one of ordinary skill in the art at the time the invention was made, without the benefit of "hindsight."

10. I have been asked to give my opinion, based on my experience, of the level of skill in which a person of ordinary skill in the food technology art has. In my experience, a person of ordinary skill in the food science art has at least a Bachelors Degree, and at least three to six years of experience working in the food science field. Those with greater experience can make up for the lack of a Bachelors Degree, and those with advanced degrees can probably come up to speed more quickly than three to six years.

11. Considered as a whole, the prior art teaches one of ordinary skill in the art the necessity of using corn starch in food coatings made from vegetable and/or cereal materials, especially coatings for potatoes to be fried. My '189 patent is directed to a food coating, especially for potatoes to be fried, comprising corn starch, corn flour and dextrin. It is typical for such food coatings to include corn starch. All of the patents listed in the "Background of the Invention" of the above-identified Cheree Stevens patent application are directed to food coatings which include corn starch. To my knowledge, all commercial vegetable and/or cereal based coatings sold prior to the date of this invention, had included corn starch.

12. Accordingly, both Cheree Stevens and I were surprised to discover that Cheree had obtained a coating giving outstanding crispness, mouth feel and hold time in a food coating which was substantially free of corn starch, by using a rice component and a dextrin component in particular ratios and within a particular range. Nor was starch required from any hybrid or genetically modified plants having the *aedu* or *dusu2* genotype, which I believe as a practical matter can only be a corn starch.

13. Counsel prosecuting the above-identified patent application have asked me to review additional prior art to determine whether its teachings are consistent with the prior art as I know it, i.e. teaching the importance of using corn starch in food coatings, especially french fry potato food coatings. I believe the additional art would, considered with the prior art as a whole, teach those of ordinary skill in the art the importance of using corn starch in such coatings.

14. None of the prior art which I have reviewed discloses or suggests to one of ordinary skill in this art a food coating comprising from about 25% to about 70% by weight of the combination of a rice component and a dextrin component in a ratio of rice to dextrin of from about 1:2 to about 5:1, where the composition is substantially free of corn starch, and is substantially free of starches from plants crossbred or modified to contain either the dull sugary 2 genotype (*dusu2*) or the amylose extender dull genotype (*aedu*).

15. I have been asked to review Higgins Patent 5,976,607 (Exhibit 2) and Rogols et al. 5,897,898 (Exhibit 3), which I am informed were cited by the Examiner in an Office

Action pertaining to this patent application. The Higgins '607 reference discloses a food coating composition containing from about 25% to about 90% by weight corn starch. Rogols et al. '898 emphasizes utilizing a hydrolyzed starch having a dextrose equivalence of from about 0.2 to about 0.8, with corn and potato starch being particularly preferred. While some of the examples used potato starch instead of corn starch, and while those examples include rice flour, they do not utilize dextrin (see Table 1, Table 3 and Table 4). While the formula of Table 3 includes rice flour and "maltodextrin," maltodextrin is not "dextrin."

16. I have also reviewed a number of additional prior art references which are being brought to the attention of the Patent Office. Exhibit 4 is a prior art batter formula which employed 14% corn starch, dextrin, rice flour and other ingredients.

17. Newly submitted Rogols 6,022,569 (Exhibit 5) employs corn starch in many of its examples, in that corn starch comprises 40% of "Crisp Coat® UC," the other 60% comprising tapioca dextrin. The newly cited Horn Patents 6,080,434 (Exhibit 6) and 6,159,521 (Exhibit 7) claim coatings comprising at least 2% by weight corn starch. The newly cited Friedman Patent 5,928,693 (Exhibit 8) teaches a clear coat food coating including rice, flour, dextrin within the claimed range, and a starch, which as a practical matter comprises corn starch. The starch is said to be from a crossbred or genetically modified plant containing the aedu or dusu2 genotype, which it is believed currently has only been done with maize.

18. Regarding the content of "Crispcoat™ UC," which was used in some of the examples in Rogols Patent 6,022,569, attached hereto as Exhibit 9 is a "Technical Service Bulletin" from *National Starch and Chemical Company* dealing with Crispcoat™ UC. As can be seen by reference to the document, "CRISPCOAT UC is a specialty blend of high amylose corn starch and tapioca dextrin."

19. On two separate occasions, I have contacted representatives of *National Starch and Chemical Company* to determine the percentage distribution between corn starch and dextrin in Crispcoat™ UC. On both occasions, I was informed that corn starch comprises 40% of Crispcoat™ UC and dextrin comprises 60% of Crispcoat™ UC. One can see therefore, that the ratio of rice flour to dextrin in any of the examples in Tables 6-11 fall outside of the

claimed range of the present application, i.e. a rice to dextrin ratio of from about 1:2 to about 5:1. It appears that the closest one comes to that ratio range is in the coatings of Tables 7 and 8 which employ 45% rice flour and 12% Crisp Coat® UC. The ratio of rice to dextrin in those examples is 6:1, and those examples also include approximately 5% corn starch.

20. It has been pointed out to me by counsel that United States Patents 6,159,521 and 6,080,434 to Horn include Formulas 4A-4E of Example 4 and Formulas 3C, 3G and 3H of Example 3 which, on their face, appear to comprise between 25 and 75% of a combination of rice flour and dextrin, in a rice to dextrin ratio of from about 1:2 to about 5:1, which are substantially free of corn starch. However, I do not believe that anyone of ordinary skill in the food coating art would read these examples as teaching such a food coating composition.

21. The Horn patents emphasize the importance of using at least 2% by weight of a crosslinked dent corn starch. The claims of both Horn patents are directed to the food coatings containing at least 2% corn starch.

22. Example 4 of the Horn patents specifically state that it is a comparison of food coating formulas employing corn starches having different levels of acetylation. Yet Table 4-1 refers to the use of acetylated potato starch. I believe that one of ordinary skill in this art would readily identify this as a typographical error, since the example obviously has to do with different acetylated corn starches.

23. Similarly the description of Example 3 indicates that it is the comparison of various coating formulations using potato starches in combination with different types of corn starch. Since two different potato starches are listed at the top of Table 3 and a 5% acetylated corn starch, a crosslinked corn starch and a 4% acetylated "potato" starch are listed at the bottom of the Table, I believe those of ordinary skill in the art would assume that the 4% acetylated "potato starch" listed with the other corn starches at the bottom of the table is in fact a corn starch.

24. To the extent that Examples 3G and 3H do not appear to list the use of corn starch, I believe that those of ordinary skill in the art would either regard this to be an error,

particularly in view of the fact that the percentages of the ingredients do not accurately add up to 100%, or they would simply interpret these examples as failed experiments.

25. Thus, I believe that those of ordinary skill in this art would view the Horn patents as teaching away from the use of a rice component and dextrin component food coating which is substantially free of corn starch.

26. As I stated above in paragraph 17, I believe that the starch referred to and claimed in Friedman Patent 5,928,693 is, as a practical matter, corn starch. I include herewith a paper submitted by David V. Glover, Department of Agronomy, Purdue University (Exhibit 10), which supports this conclusion.

27. The '693 patent states at column 3 that the use of starches from plants with the amylose extender dull genotype is taught in U.S. Patents 5,497,586; 5,260,076; 5,120,562; 5,035,912 and 4,790,997. The reference to Patent 5,497,586 is evidentially a typographical error or a misprint, since the 5,497,586 patent is directed to a framed glazing unit. Patent 5,260,076 (Exhibit 11), like the '693 patent itself, indicates that while the amylose extender gene is present in maize and barley, it indicates only maize for the dull gene and the sugary 2 gene. Thus, as a practical matter, the starch referred to is corn starch.

28. Patent 5,120,562 (Exhibit 12) relates to a starch batter, and states that:

"Any plant that produces edible starch and can be crossbred to produce a plant that is an aedu [amylose extender dull] homozygous genotype may be used to provide the aedu starch. Plants that produce edible aedu starch are obtained not only by standard plant cross-breeding techniques by also by moving the aeaedudu genotype to another portion of the plant genome by translocation, inversion or other methods of chromosome engineering. The preferred plant source is maize."  
(Col. 2, lines 1-9).

Thus, as above, this reference refers as a practical matter to corn starch.

29. Patent 5,035,912 (Exhibit 13) discloses a starch jelly candy which uses an amylose extender dull starch (aedu) and a dull sugary 2 starch (dusu2) (column 3, lines 57-

67). The patent does not indicate what specific plants can be used to obtain such starches, but refers back to Patents 4,790,997 and 4,792,458.

30. Patent 4,790,997 (Exhibit 14) relates to food stuffs containing starch having the amylose extender dull genotype, but makes the same comment as the '693 patent to the effect that while the amylose extender mutant gene is present in maize and barley, the dull genotype is present only in maize. As with the other references above, it states that "maize is the preferred plant source."

31. Patent 4,792,458 (Exhibit 15) also supports my conclusion that as a practical matter, a starch having the aedu genotype or the dusu2 genotype is a corn starch, in that it discloses food stuffs containing such starches with maize being indicated as the preferred plant source. The '458 patent does assert, however, the theoretical possibility that both the su2 and the dull mutant genes can be found in barley and sorghum, as well as maize. If this assertion is true, it is at least theoretically possible that the dusu2 genotype could be engineered using barley or sorghum, as well as maize. However as a practical matter, it is believed that the dusu2 genotype has only been engineered or crossbred using maize starch from a plant having the dusu2 genotype or the aedu genotype is, as a practical matter, corn starch.

32. All statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true, and further, these statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 USC §1001, and that such willful false statements may jeopardize the validity of this application or any patent issued thereon.

July 8, 2003  
Date

John F. Stevens  
John Stevens

# EXHIBIT 1

# JOHN STEVENS

200 Cobblestone Lane • Idaho Falls, Idaho 83404 • (208) 529-9027

---

## OBJECTIVE

Management position in food-related product development

## PROFESSIONAL SUMMARY

Director with 28 years of product management experience. Demonstrated ability to structure innovative solutions to complex problems that allow for increased profits. Proven ability to develop quality teams that motivate others to their peak performance and reduce execution time.

## CAREER HISTORY

### **NEWLY WEDS FOODS, INC.**

Idaho Falls, Idaho

1996 – 1999

#### **DIRECTOR, NORTHWEST REGION TECHNICAL SERVICES**

- Established, staffed, and directed all formula, process, specification, and commercialization of seasoned and clear coat french fry batters for all french fry processors and chain accounts throughout the United States.
- Worked directly with all french fry processors to define, develop, and implement process improvements, and introduce new and cost reduced products to their lines.
- Salvaged failing business at key customer by demonstrating technical expertise with flours, starches, seasonings, processing capability, and implementing process savings in excess of \$1,000,000 per year.
- Developed and commercialized a signature clear coat french fry for a major processor and for a major national chain account.
- Developed patent-pending process for maintaining light colored fried potato products throughout the year.

### **MILES WILLARD COMPANY**

Idaho Falls, Idaho

1994 – 1996

#### **RESEARCH MANAGER**

- Directed all frozen and non-snack dehydrated potato development, creating 8 new product opportunities and bringing on board two new clients on a royalty-paying basis.
- Developed patented clear coat french fry product and patent-pending processes for reduced fat coated fries, and for improved chopped & formed product.

### **McCAIN FOODS, INC.**

Frozen Foods Division – Othello Washington

1991 – 1994

#### **DIRECTOR, TECHNICAL SERVICES**

- Directed all research, quality assurance, nutrition, specification, labeling, and internal sensory for the USA multi-plant operation.
- Commercialized signature french fry line, resulting in \$30,000,000 sales.
- Commercialized first flavored marinade french fry line valued at \$10,000,000, obtaining patent.

### **UNIVERSAL FOODS CORPORATION**

Frozen Foods Division – Twin Falls, Idaho

1989 – 1991

#### **R&D MANAGER, NEW PRODUCTS**

- Directed coated french fry developments and internal sensory resulting in \$60,000,000 additional sales.
- Developed first clear coat french fry now having estimated market sales of over 1 billion pounds per year.
- Instituted cost reduction programs resulting in \$4,000,000 savings per year.



# JOHN STEVENS

---

## STEVENS LABORATORIES, INC.

1988 – 1989

Rochester, New York

### GENERAL MANAGER

- Took over family business of food & wastewater analyses from father who was retiring. Computerized and streamlined operations.

## THE PILLSBURY COMPANY

1985 – 1988

Minneapolis, Minnesota

- Directed all dehydrated potato maintenance valued at \$150,000,000.
- Created concept and development of marketed microwave potato specialty line valued at \$20,000,000.
- Headed team for the development of 12 marketed food service bakery toppings valued at \$8,000,000.
- Developed and implemented cost reduction programs amounting to more than \$1,000,000, achieving an award for outstanding cost reduction contribution.
- Developed a sulfite program that established benchmarks for the FDA and resulted in identifying the ability to significantly reduce use levels.

## THE R. T. FRENCH COMPANY

1970 – 1985

(Potato Division acquired by The Pillsbury Company in 1985)

Rochester, New York / Idaho Falls, Idaho

### MANAGER, FOOD SERVICE BUSINESS DEVELOPMENT

1984 – 1985

- Identified new business areas resulting in a \$10,000,000 development strategy.
- Built the food service laboratory and directed programs requiring identifying and implementing new package design / copy, resulting in increased product marketability.
- Developed and launched a new concept of potato in a pouch resulting in \$15,000,000 sales.
- Worked directly with distributorships, national account managers, brokers, and ad / creative design houses.

### MANAGER, PRODUCT RESEARCH & DEVELOPMENT

1978 – 1984

- Built the research facility and directed new product and sensory programs resulting in \$32,000,000 additional retail sales per year and \$40,000,000 food service sales per year.
- Constructed and directed cost reduction programs resulting in \$6,000,000 savings.
- Oversaw development of specifications, nutrition labeling, and package design.

### SUPERVISOR, TECHNICAL SERVICES

1976 – 1978

### SENIOR SCIENTIST

1974 – 1976

### FOOD SCIENTIST

1970 – 1974

- Responsible for the development of the Automash Potato Dispenser system, and sales personnel training resulting in \$8,000,000 sales per year. Developed specialty blend mashed products and food service casseroles for major chain accounts resulting in \$50,000,000 sales. Developed wet and dry system blends such as mustard, ketchup, spaghetti, barbecue, and specialty sauces.

## EDUCATION

Cornell University, Ithaca, New York  
The College of Food and Dairy Science

Bachelor of Science Degree, June 1970  
(Food and Dairy Science)

## REFERENCES FURNISHED UPON REQUEST

## EXHIBIT 2



US005976607A

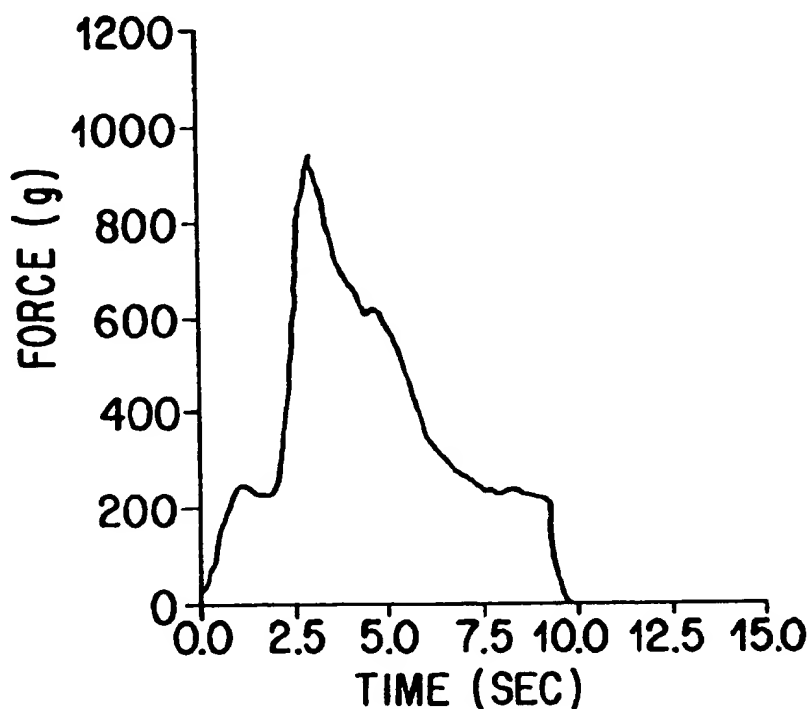
**United States Patent** [19]**Higgins et al.**[11] **Patent Number:** **5,976,607**[45] **Date of Patent:** **\*Nov. 2, 1999**[54] **WATER DISPERSIBLE COATING  
COMPOSITION FOR FAT-FRIED FOODS**[75] Inventors: **Camille Higgins**, Rockford; **Jun Qian**,  
Loves Park, both of Ill.; **Kevin**  
**Williams**, Beloit, Wis.[73] Assignee: **Kerry Inc.**, Beloit, Wis.[\*] Notice: This patent is subject to a terminal dis-  
claimer.[21] Appl. No.: **09/038,045**[22] Filed: **Mar. 11, 1998****Related U.S. Application Data**[63] Continuation-in-part of application No. 08/855,668, May  
14, 1997, Pat. No. 5,849,351.[51] Int. Cl.<sup>6</sup> ..... **A23L 1/216**[52] U.S. Cl. .... **426/637; 426/102; 426/305;**  
**426/438**[58] Field of Search ..... **426/637, 102,**  
**426/305, 438**[56] **References Cited****U.S. PATENT DOCUMENTS**

3,424,591 1/1969 Gold ..... 99/100

3,751,268	8/1973	Van Patten et al. ....	99/100
4,551,340	11/1985	El-Hag et al. ....	426/437
5,004,616	4/1991	Shanbhag et al. ....	426/102
5,059,435	10/1991	Sloan et al. ....	426/102
5,302,410	4/1994	Calder et al. ....	426/637
5,393,552	2/1995	Busacker et al. ....	426/637
5,622,741	4/1997	Stubbs et al. ....	426/243
5,648,110	7/1997	Wu et al. ....	426/102

*Primary Examiner*—Nina Bhat*Attorney, Agent, or Firm*—Griffin, Butler, Whisenhunt &  
Szipl, LLP[57] **ABSTRACT**

A water dispersible coating composition for fat-fried foods contains a starch, a stabilizing agent, an acid salt and a leavening agent. The improvement is the use of a combination of at least one modified cornstarch and rice flour, in respective weight proportions of about 10:1 to 1:1, as the starch. The composition may also contain a dextrin, a high amylose starch, modified potato starch and a vegetable oil. The composition is dispersed in an aqueous medium having from about 20 to 90 weight percent of the composition for application to a food prior to fat frying.

**14 Claims, 1 Drawing Sheet**

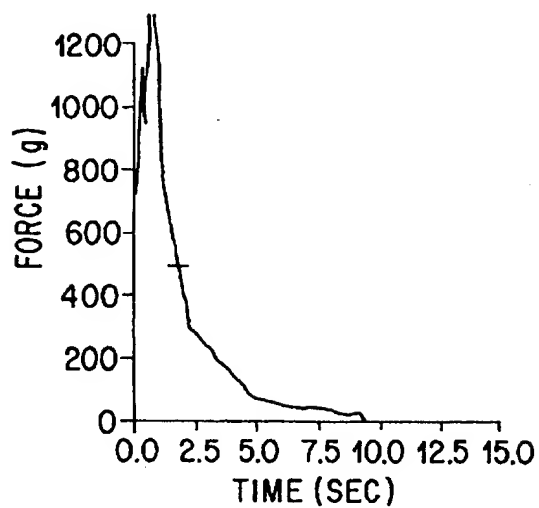


FIG. 1

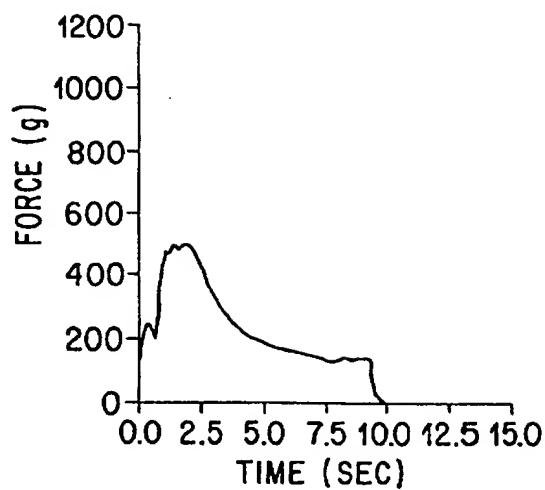


FIG. 2

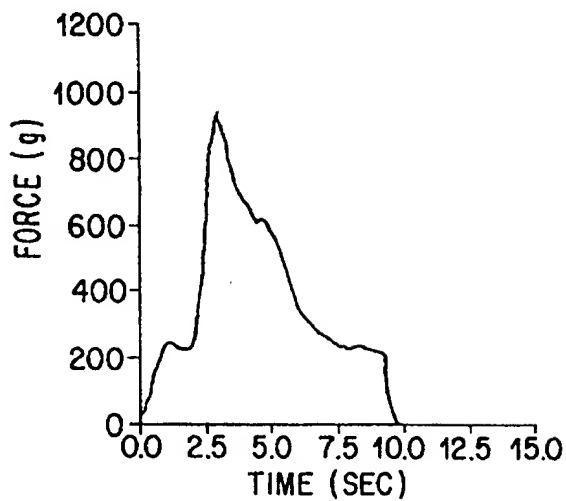


FIG. 3

## WATER DISPERSIBLE COATING COMPOSITION FOR FAT-FRIED FOODS

This application is a continuation-in-part of U.S. application Ser. No. 08/855,668, filed on May 14, 1997 now U.S. Pat. No. 5,849,351.

The present invention relates to a water dispersible coating composition for fat-fried foods, and more particularly to a coating which may be substantially clear in appearance when on a fried food and which will substantially prolong the serving time of the fried food.

### BACKGROUND OF THE INVENTION

A difficult problem in the art is that of prolonging the serving time for fat-fried foods, and particularly deep fat-fried foods. The serving time after frying such foods varies with the particular food, but generally speaking, the serving time is quite short. While the difficulties engendered with serving time differs somewhat from fried food to fried food, generally common to all of the fried foods is that with prolonged serving time, i.e. the time between frying and serving, the fried foods lose the desired texture. In fried chicken, for example, the chicken, after some prolonged time between frying and serving (serving time), e.g. 10 minutes, will have a somewhat oily and dry taste. Fried seafood, e.g. shrimp, scallops and the like, develop something of a soggy taste, texture and mouth feel with prolonged serving time. Vegetables, e.g. mushrooms, become limp. However, probably French fried potatoes deteriorate more rapidly with prolonged serving time than any other fried food. The deterioration causes the French fried potatoes to not only have an oily and dry taste, but the potatoes also become somewhat limp, as opposed to the fresh potato taste and crispness of the freshly fried potatoes.

The serving time becomes quite critical in many food preparation operations, for example, in fast food restaurants, institutional kitchens and the like. In fast food restaurants, in order to provide such fast service, it is necessary to prepare some of the foods prior to being ordered, and the serving time therefor becomes critical for customer satisfaction. In institutional kitchens and the like, there is always a time lag between preparation of the food and transportation of that food to the consumer.

The art has long struggled with methods, coatings and compositions for prolonging the serving time. These vary with the particular foods involved, but, generally, all of these approaches are toward some protective coating or treatment which will slow the deterioration of the texture and taste of the food after frying. French fried potatoes have been a very difficult problem for the art since certain coatings and the like may be relatively successful for other foods, but when applied to French fried potatoes, those coatings fall far short of desirability.

The reasons for loss of texture and taste of such fried foods have never been clear in the art. Some investigators have asserted that oil infusion into the fried foods is responsible, while others have asserted that loss of moisture from the fried foods is responsible. Most likely, both are responsible for the loss of texture and taste.

Generally speaking, the art has concentrated on water dispersible coating compositions for such fried foods which contain a starch, a stabilizing agent, an acid salt and a leavening agent. The starch, during frying, is presumed to be converted to something of an oil and moisture barrier. The stabilizing agent provides a stable dispersion of the starch in an aqueous medium for applying the coating to the food, and

the acid salt is used to prevent discoloration, particularly in regard to French fried potatoes, and may function as part of a leavening system. A leavening agent is used to provide a somewhat crispy texture.

However, the prior art approaches have not been entirely satisfactory, especially for French fried potatoes, since it is quite common for French fried potatoes for use by fast food restaurants and institutional kitchens to be partially fried (parfried) in hot oil and then quick frozen for shipment to the user. This allows a very quick frying of the potatoes in hot oil by the user, e.g. a fast food restaurant. During the time period from parfrying and freezing by the manufacturer to refrying (finish frying) by the user, even in the frozen condition, there is opportunity for residual oil from the parfrying and moisture in the food to pass through the coating. Thus, when the refrying (finish frying) is achieved, by the ultimate user, there is already a certain amount of oil infusion and moisture loss associated with the potatoes, and the additional oil infusion into and the moisture loss from the potatoes during finish frying and during the serving time can make the serving time quite short. Similar parfrying and freezing takes place with other foods designed for fast food restaurants and institutional use, e.g. chicken, seafood, vegetables, etc.

In U.S. Pat. No. 3,424,591, issued on Jan. 28, 1969, it is pointed out that potatoes have a variable chemical and physical composition, e.g. the amount of reducing sugars, moisture, solids, protein, carbohydrate, etc., and that a sugar, such as dextrose or glucose, is often used in coatings for the potatoes to avoid the affects of some of that variation by providing a richer color to the fried potatoes. It is also pointed out that calcium lactate can be used as a stiffening agent to improve the physical appearance and plate life (serving time). To avoid these problems, that patent suggests treating the potatoes with a chemically modified natural hydrocolloid to form a thin coating or film on the potato surface prior to deep fat frying. Particularly recommended is alkyl cellulose ether as the hydrocolloid, and particularly those which form thermally reversible gels in aqueous solution, such as methylcellulose.

U.S. Pat. No. 3,751,268, issued on Aug. 7, 1973, recognizes the same problem with serving time of French fried potatoes and points out that prior attempts include coating the potatoes before frying with gelatinized starch solution of either a modified or unmodified starch, but that practice has proved ineffective. The patent suggests coating the potatoes with ungelatinized unmodified high amylose starch having an amylose content above 50%. In this regard, the patent points out that it is intended that the starches have a pure amylose content of more than 50% and the starches have undergone no physical or chemical treatment to change the properties of the refined native starch.

U.S. Pat. No. 4,551,340, issued on Nov. 5, 1985, again addresses the problem of French fried potatoes and suggests that the potatoes be wetted with an aqueous suspension of a film-forming hydrocolloid, glucose polymer, most preferable potato starch, which has not been pregelatinized. It is said that that hydrocolloid film functions not only to minimize oil absorption but also to control moisture loss during frying and in oven reheating.

U.S. Pat. No. 5,004,616, issued on Apr. 2, 1991, describes a process for preparing improved French fried potatoes for subsequent reheating in a microwave oven where the potatoes are toasted with potato granules to provide a thin coating of toasted potato granules which adheres to the surface of the potato strips. After the potato strips are

blanched (described more fully hereinafter), the potatoes are dust coated with the potato granules. Thus, the protective coating is a potato starch.

U.S. Pat. No. 5,059,435, issued Oct. 22, 1991, addresses the same problem and reviews the prior art in connection with the coatings. Particularly, that patent addresses the ungelatinized modified high amylose starch described in U.S. Pat. No. 3,751,268, discussed above, but suggests a different coating. The patent suggests a coating comprising a combination of chemically modified ungelatinized potato starch, chemically modified ungelatinized cornstarch, and rice flour. It is stated in that patent that the potato starch in the composition functions to produce optimal results. Particularly, it is said that raw potato starch which has been modified through known chemical cross-linking processes produces an optimal coating, since it minimizes sticking or clumping of the strips during processing and coats the potato strips evenly. It is further said that the combination of the ungelatinized potato starch, modified ungelatinized cornstarch, and rice flour is important, since the potato starch and cornstarch contribute crispness to the coating since they are not gelatinized prior to par-frying, and the rice flour provides tenderness to the finished product.

U.S. Pat. No. 5,302,410, issued on Apr. 12, 1994, reports that the prior approaches for French fried potatoes by using gums, high amylose starches and other hydrocolloids have not fulfilled expectations and suggests coating the potatoes before par-frying with an aqueous solution of the hydrolyzed starch product such as dextrin or maltodextrin.

U.S. Pat. No. 5,393,552, issued on Feb. 28, 1995, is a continuation-in-part of U.S. Pat. No. 5,302,410 and suggests the same coating but used in a variation of the process.

Accordingly, the art has long struggled toward providing an acceptable coating for fat-fried foods, especially deep fat-fried foods, which will prolong the serving time, but as the prior art discussed above illustrates, the art has not produced a satisfactory coating, and many different approaches have been used in efforts to solve the problem of prolonged serving time. It would, therefore, be of distinct advantage to the art to provide a coating for fried foods, particularly French fried potatoes, which allows a much longer serving time while yet retaining the fresh fried appearance, texture and taste.

#### SUMMARY OF THE INVENTION

It has now been discovered that a water dispersible coating composition for fat-fried foods may be provided which is, in effect, an improvement over prior art coatings. As noted above, those prior art coatings, generally, comprise a starch, a stabilizing agent, an acid salt and a leavening agent. Also, as the above-discussed prior art illustrates, the art has suggested many different starches or other hydrocolloid agents as the basic ingredient of the coating composition.

The present improvement is based on the discovery that if the starch in that conventional composition is a combination of at least one modified cornstarch and rice flour in certain weight proportions, the serving time can be substantially prolonged. In addition, it has been discovered that some embodiments of such a coating may be clear on the fried food, especially potatoes, so that the coating does not obscure the natural appearance of the food.

It has also been discovered that, to provide a coating with such characteristic, the weight proportion of the at least one cornstarch to rice flour can range from about 8:1 to 1.5:1, but is more preferably from about 10:1 to 4:1.

It has also been found that other ingredients may be added to the present coating composition to provide other advantages, including the use of a dextrin, e.g. tapioca dextrin, the use of a high amylose starch, the use of modified potato starch and the use of vegetable oil.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1, 2, and 3 show bending test results of fried potatoes with and without the present coating.

#### DESCRIPTION OF PREFERRED EMBODIMENTS

As noted above, the basic starch in the present composition is a combination of at least one modified cornstarch and rice flour. Modified cornstarch and rice flour are standard commercial ingredients and may be obtained from a variety of suppliers. Cornstarch is commercially modified by known cross-linking and chemical substitution processes, such as to produce acid hydrolyzed, phosphate modified and hydroxy-alkyl substituted starches. However, these processes result in some differences in the modified cornstarch from manufacturer to manufacturer and from time-to-time, which can introduce variability to the modified cornstarch and, thus, in the present coating. In one aspect of the invention, it has been found that if commercially available modified cornstarches are blended, a more balanced and uniform coating results. In another aspect, blended modified cornstarches can improve the coating results, especially for certain fried foods and especially for French-fried potatoes. Hence, the modified cornstarch of the present invention is at least one modified cornstarch, but preferably is a blend of more than one commercially available modified cornstarch, e.g. two or three or four or more.

Modified cornstarches, as noted above, have some variability. Some produce a more smooth appearance of the fried coating, while others produce a more rough appearance. Some transmit more moisture from the fried foods, e.g. during serving time, while others transmit less. Some are better film formers than others. While any of the commercially available modified cornstarches alone will provide a satisfactory coating for purposes of the present invention, a better coating can be obtained by taking advantage of these slightly different properties of the commercially available modified cornstarches. Thus, for example, combining at various ratios a low moisture transmission/smooth appearance cornstarch with a high moisture transmission/rough appearance cornstarch, the various combinations can provide a variety of moisture transmissions and smooth/rough appearance which will be suitable for a variety of fried foods.

These slightly different properties of the commercially available modified cornstarches are generally known to the art, and by combining the cornstarches in various ratios, a limited number of trials can easily show combinations of the starches that are better for certain foods. For example, in the case of French fried potatoes, the ideal coating is somewhat clear, but with some roughness (not shiny), has a moderate moisture transmission and can form a substantially continuous film. A very good combination of commercially available modified cornstarches for French fried potatoes can be provided as follows. National Starch 6997:118 produces a smooth but somewhat chewy coating and has very low moisture transmission which will decrease the serving time before the potatoes become slightly soggy. Puregel PURECOTE B790 (Grain Processing Corp.) provides a somewhat rough and crispy coating. The moisture transmission is

higher and will allow the fried, coated potatoes to become somewhat hard during serving time. This starch is, also, not a good film former. Puregel PURE-COTE B992 (Grain Processing Corp.) is a good film former with medium moisture transmission and roughness. AD STARCH (National Starch and Chemical Co.) is a good film former. Thus, for example by combining several or more of commercially available starches in a single coating composition, that composition can provide a fried coating that is somewhat clear, slightly rough and crispy, with moderate moisture transmission and a fully formed film, i.e. nearly an ideal coating for French fried potatoes. Further, the coating can be easily tailored to specific conditions to be encountered by the fried potatoes simply by adjusting the ratios of the chosen modified starch components. For example, the amounts of these components can vary widely, as desired, e.g. National Starch 6997:118 10-60%, Puregel PURE-COTE B790 5-40%, Puregel PURE-COTE B992 5-40%, and AD STARCH 5-30%, of the total coating composition. By using the components in the foregoing percentages, an excellent coating for French fried potatoes is provided.

The reasons for those results of such mixtures of commercially available modified cornstarches are not clear. However, such commercially available cornstarches have slightly different gelatinization temperatures and, hence, rates of gelatinization at frying temperatures. For example, the gelatinization temperatures of the National starch is 53° C.; the PURE-COTE is 56° C.; and the Puregel is 51° C. While these gelatinization temperatures are not greatly different, it is believed that the differences are sufficient to cause differences in the predominant gelatinizations of the starches as frying proceeds and the temperatures of the coating composition increases, which causes the different properties of fried coatings with the different mixtures of commercially available modified cornstarches.

From the above, it will be apparent why it is important for the cornstarches of the present invention to be in the ungelatinized form when preparing the coating composition. If the starches were in a gelatinized form, the above-noted actions would not be obtained during frying of the coated foods.

The modified cornstarch will usually predominate in proportions to the rice flour, since the modified cornstarch is the primary texture-enhancing ingredient of the coating composition. However, the rice flour is equally important in that the rice flour, in combination with the modified cornstarch, ensures that the coating is virtually undetectable by the consumer, especially in that the rice flour tenderizes the coating so as to make the coating on the fried food essentially undetectable from a texture point of view. It has been found that if modified cornstarch alone is used, then the coating is more crunchy than desired, e.g. more crunchy than a natural French fried potato, and can be detected by consumers. However, with the addition of the rice flour in the present proportions, the coating becomes far less crunchy, and with the rice flour in combination with the modified cornstarch, the coating is virtually undetectable by the consumer.

While weight proportions of the modified cornstarch to the rice flour can vary between about 10:1 and 1:1, as noted above, it is preferable that the weight proportions are between about 8:1 to 1.5:1, i.e. with a greater amount of rice flour in the 1.5:1 ratio than in the 8:1 ratio. An amount of rice flour up to a ratio of about 7:1 provides quite adequate film formation for prolonged serving time and a texture to the coating on the fried potato which is virtually undetectable. There is some trade-off in prolonged serving time at higher

ratios of rice flour to cornstarch, but with up to the 7:1 ratio of modified cornstarch to rice flour the serving time is still quite acceptable.

The stabilizing agents can be those conventionally used in the art, e.g. gums, hydrocolloids and the like, for example, guar gum, the celluloses, etc., and the stabilizing agent is not critical, since it merely functions to form a stable dispersion of the composition in an aqueous medium for applying to the food. However, it is preferable that xanthan gum be used in this regard, since it has been found that xanthan gum functions as a very good stabilizing agent and imparts no detectable presence in the fried coating.

An acid salt is used in these compositions, such as sodium acid pyrophosphate (SAPP), sodium aluminum phosphate (SALP) or monocalcium phosphate (MCP), although other acid salts may be used. As noted above, these salts improve texture during prolonged serving time.

Also, as is conventional in these compositions, a leavening agent is used so as to provide a crispy texture. Conventional leavening agents, such as monocalcium phosphate (MCP), may be used, but a preferred leavening agent is the combination of the acid salt and a gas-producing base, such as sodium bicarbonate, in sufficient amount to neutralize the acid salt. However, other carbonates or other leavening agents may be used.

The composition may also contain a dextrin which is used to assist in film formation. Tapioca dextrin is particularly useful in this regard, although potato dextrin may be used. When a dextrin is used, the dextrin will normally be in a weight proportion to the cornstarch of from 20:1 to 5:1.

The composition may also contain a high amylose starch, such as AMYLO GEL 03003 (Cerestar Co.). The high amylose starch affects texture and is therefore useful in the composition. When a high amylose starch is used, the weight proportion of cornstarch to high amylose starch will be from about 20:1 to 3:1. The amylose content of the high amylose starch should be at least 50% but more preferably about 70% or greater.

In some coatings, especially when the clearness of the coating is not important, it is advantageous to include in the coating a substantial amount of modified potato starch. Modified potato starch is potato starch which has been modified by chemical treatment to effect cross-linking of the starch, and is commercially available, e.g. PERFECTAMYLO FFC. The use of modified potato starch decreases the crunchy texture of the coating, which is desirable for certain coatings. The modified potato starch can be used in a wide range to adjust the crunchy texture, e.g. 10-80% of the total solids of the coating composition, but most usually will be about 15-60% of the composition.

A very small amount of vegetable oil can also be used in the composition, primarily, for controlling the dust of the composition during use and handling, e.g. 0.1% to 1.0% of the total weight of the solids of the coating.

The composition may also contain preservatives, tints and the like, which are common in the art. The composition may also have other flavoring agents, such as salt, spices, e.g. paprika, and the like.

The composition may be prepared for direct use by dispersing in an aqueous medium, e.g. water, having from 20 to 90 weight percent of the composition in the aqueous medium.

In a preferred embodiment, the composition will contain all of the at least one modified cornstarch, the rice flour, the stabilizing agent, a leavening agent or agents and the acid

salt. More preferably, the leavening agent is constituted by a combination of the acid salt and a base. In a further preferred embodiment, the composition will include a dextrin and a vegetable oil. In a preferred composition, as a percentage of the dry composition, the modified cornstarches will be 45–90%, the rice flour will be 5–20%, the dextrin will be 1–15%, the high amylose starch will be 2–15%, the stabilizing agent, e.g. xanthan gum, will be 0.05–4.5% and vegetable oil will be 0.05 to 0.5%. The leavening most preferably is the combination of the acid salt, e.g. SAPP, and a base. For example, good combinations are SAPP (acid salt) and sodium bicarbonate (leavening base) or SAPP and monocalcium phosphate and sodium bicarbonate, where the amount of the acid salt is from 0.5 to 2% and the base will be sufficient to substantially neutralize the acid salt for leavening purposes.

Where a less crunchy texture is desired, the coating composition may contain modified potato starch in amounts between about 15–60% of the weight of the solids in the coating composition. Thus, as a preferred composition for that purpose, the modified cornstarch is 25% to 40%, the rice flour is 8% to 25%, the dextrin is 0% to 15%, and the modified potato starch is 15% to 60%, with the remainder of the ingredients as specified above. Modified potato starch, such as PERFECTAMYLO FFC (AVEBE Co.) is a di-starch phosphate of potato starch. The modified starch should be ungelatinized.

In using the composition, all of the above dry ingredients are dry blended to make a homogenous mixture thereof. The dry ingredients are then mixed with water to the desired concentrations of solids, e.g. from about 20% to 90% by weight of solids in the composition. However, more usually that solids content will be between about 30% and 70%, and more desirably between about 30% and 60%. Any usual dispersing apparatus, such as a high shear mixer, e.g. a LIGHTNING mixer, is suitable in this regard.

The food, e.g. vegetables, potatoes, chicken, meat, seafood, is prepared in the usual manner. For example, with potatoes, the potatoes are washed, scrubbed, peeled and cut into strips, which is common to the art. The strips are then usually blanched, in a conventional manner. The potatoes are then dried and placed in an aqueous solution containing a darkening preventive material, such as sodium acid pyrophosphate (SAPP). That solution may also contain salt and dextrose for providing a golden color to the potatoes. The potatoes are then placed on a tray and oven dried and, after drying, passed through an aqueous waterfall containing the suspension of the coating composition. After passing through the waterfall, the strips are placed in an open-kettle fryer containing cooking oil at conventional temperatures, e.g. about 340° F. to about 400° F. The length of time in the fryer depends upon whether the food, e.g. potatoes, is to be completely fried or simply parfried. Parfrying is a process in which the food is partially fried in order to preserve the food, and then the food is frozen for subsequent reheating (also called finish frying).

The invention will now be illustrated by the following Examples. In the Examples, as well as the specification and claims, all percentages and ratios are by weight, unless otherwise indicated.

#### EXAMPLE 1

Raw Russett-Burbank potatoes from the Washington/Idaho area were washed, scrubbed, peeled and cut into strips having a 5/16 inch square cross-section.

The strips were blanched in 170° F. water for about 7 minutes. They were drained and placed in a warm aqueous

solution (130° F.) containing 0.5% sodium acid pyrophosphate (SAPP) and 4.0% salt (NaCl) for 30 seconds. Then they were placed on a tray and oven dried for about 10 minutes at 180–190° F. to reach approximately a target reduction in weight (moisture loss) of 18%. After drying, they were passed under an aqueous waterfall containing the following suspension of dry ingredients at an overall concentration of 40%:

Ingredient	Weight %
Blend of Modified Cornstarches (National Starch 6997:118 (35%); Purecote B790 (17%) and Puregel B992 (17%) - Grain Processing Corp.)	69
Rice Flour	16
Tapioca Dextrin	7.5
High-amylose Starch	5.0
SAPP 40	1.1
Sodium Bicarbonate	0.8
Xanthan Gum	0.15
Vegetable Oil	0.10
Natural Flavor	0.35

The suspension was prepared by preblending 400 grams of the dry ingredients, then adding 600 grams of water to the dry ingredients and stirring until the coating was homogeneous.

After passing through the waterfall, the strips were placed in an open-kettle fryer containing vegetable oil at a temperature of 380° F. The coating was set and the potatoes were parfried by this process after a 40-second fry time. The strips were then flash frozen by placing the strips in a freezer at –30° F. for one to two hours. They were then packaged for finish frying at a later time.

Finish frying consisted of frying the parfried strips at a temperature of 350° F. for 2.5 minutes in cooking oil, e.g. vegetable oil.

To test the effect of heat-lamp stability for prolonged serving times, the fries were placed 18 inches below a 250-watt infrared heat lamp for 10 minutes and evaluated instrumentally and hedonically.

Instrumental evaluation consisted of a three-point bend test using a Stable Microsystems' TAXT2 texture analyzer. Five French fries were placed across a pair of support bars 2 mm thick and 42 mm apart. A chisel-tipped guillotine 2 mm thick and 70 mm wide was directed at the center of the gap between the bars supporting the fries. Data describing the distance of the guillotine and the forces it encountered were collected at a rate of 200 points per second during transit. An average of five replicate runs showed that fries coated with the composition described above produce a high, sharp peak in contrast to fries prepared in the same manner but uncoated.

FIGS. 1, 2 and 3 provide representative data of the above three-point bend test. FIG. 1 shows the result of a natural (uncoated) French fried potato. Note that the sharp peak and subsequent rapid decrease in force corresponds to the snapping of a relatively crisp potato. FIG. 2 shows the same natural (uncoated) potato test results after 10 minutes holding time (10 minutes after frying and being held under the above-noted heat lamp). FIG. 3 shows the same potato with the same holding time, but having the present coating thereon.

Sensory evaluations included a test similar to the three-point bend test above. A French fry was grasped between the thumb and forefinger of one hand. The forefinger of the other



hand was used to bend the French fry around the forefinger of the grasping hand. The quality of the break was noted as a range between crisp and limp.

Crunchiness during mastication was also an indicator of the quality of the coating. The qualities monitored in that context were the degree of leathery, crispy and softness characteristics.

Surface appearance of the fries was between smooth and somewhat blistered. The coating was clear and undetectable either visually or upon mastication.

### EXAMPLE 2

The same procedure of Example 1 was followed, with the exception that the composition of the coating was as follows:

Ingredient	Weight %
Blend of Modified Cornstarches (National Starch 6997:118; Purecote B790; and Puregel B992; all in the same proportions as Example 1)	80.0
Rice Flour	12.5
High-amylose Starch	5.0
SAPP 40	0.5
Monocalcium Phosphate	0.5
Sodium Bicarbonate	1.24
Xanthan Gum	0.15
Vegetable Oil	0.10
Natural Flavor	0.01

Essentially the same results as that of Example 1 were obtained.

### EXAMPLE 3

The following coating compositions were prepared and potatoes were processed therewith according to the procedure of Example 1:

Ingredients	Samples			
	A	B	C	D
Modified Corn Starches <sup>1</sup>	65	76	84	32
Rice Flour	12.3	13	13	15
Tapioca Dextrin	8			5
Salt	8			6.19
High-Amylose Starch	5	8		
Leavening (SAPP 40)	1.1	0.6	0.6	
Leavening (SALP)				0.8
Leavening (MCP)		0.5	0.5	
Sodium Bicarbonate	0.8	1.24	1.24	0.8

-continued

Ingredients	Samples			
	A	B	C	D
Paprika	0.35			
Xanthan Gum	0.15	0.1	0.125	0.11
Soybean Oil	0.1	0.1	0.1	0.1
Modified Ungelatinized Potato Starch (PERFECTAMYLO FFC)				40

<sup>1</sup>National 118, AD STARCH, PURE-COTE B790, Adhesion Starch (Kerry Ingredients)

Each of Samples A through D provided good coatings on the fried potatoes.

What is claimed is:

1. In a water dispersible coating composition for fat-fried foods, wherein the coating composition comprises a starch, a stabilizing agent, an acid salt and a leavening agent, the improvement wherein the starch consists essentially of a combination of a blend of more than one modified cornstarch and rice flour in respective weight proportions of about 8:1 to 1.5:1.

2. The composition of claim 1, wherein the composition also contains a dextrin.

3. The composition of claim 2, wherein the dextrin is tapioca dextrin.

4. The composition of claim 2, wherein the dextrin is in a weight proportion of cornstarch to dextrin of from about 20:1 to 5:1.

5. The composition of claim 1, wherein the composition also contains a high amylose starch.

6. The composition of claim 5, wherein the high amylose starch is in a weight proportion of cornstarch to high amylose starch of from about 20:1 to 3:1.

7. The composition of claim 1, wherein the composition also contains a modified potato starch.

8. The composition of claim 7, wherein the modified potato starch is from 20% to 60% of the total solids of the composition.

9. The composition of claim 1, wherein the composition also contains vegetable oil.

10. The composition of claim 9, wherein the composition contains 0.05% to 1% vegetable oil.

11. The composition of claim 1, wherein the composition is dispersed in an aqueous medium having from about 20 to 90 weight percent of the composition in the aqueous medium.

12. The composition of claim 11, wherein the composition in the aqueous medium is from about 30% to 60%.

13. The composition of claim 1, wherein the composition is disposed on a French fried potato.

14. The composition of claim 1, wherein the composition has a clear appearance on a fried food.

\* \* \* \* \*

## EXHIBIT 3



US005897898A

**United States Patent** [19]**Rogols et al.**[11] **Patent Number:** **5,897,898**[45] **Date of Patent:** **Apr. 27, 1999**[54] **PROCESS FOR PREPARING STARCH  
HYDROLYZATE COATED POTATO  
PRODUCTS**[75] Inventors: **Saul Rogols, Golden; John Harold  
Woerman, Highlands Ranch, both of  
Colo.**[73] Assignee: **Penwest Foods Co., Englewood, Colo.**[21] Appl. No.: **08/792,543**[22] Filed: **Jan. 31, 1997**[51] Int. Cl.<sup>6</sup> ..... **A23L 1/217**[52] U.S. Cl. .... **426/102; 426/302; 426/438;  
426/637**[58] Field of Search ..... **426/102, 302,  
426/438, 637, 661**[56] **References Cited****U.S. PATENT DOCUMENTS**

Re. 27,531	12/1972	Murray et al. .	
3,424,591	1/1969	Gold .....	426/441
3,597,227	8/1971	Murray et al. .	
3,751,268	8/1973	Van Patten et al. .	
4,272,553	6/1981	Bengtsson et al. ....	426/241
4,317,842	3/1982	El-Hag .....	426/302
4,418,090	11/1983	Bohrmann et al. ....	426/578
4,447,459	5/1984	Balboni et al. ....	426/441
4,504,509	3/1985	Bell et al. ....	426/548
4,529,607	7/1985	Lenchin et al. ....	426/94
4,542,030	9/1985	Haury et al. ....	426/262
4,551,340	11/1985	El-Hag .....	426/438
4,595,597	6/1986	Lenchin et al. ....	426/555
4,632,848	12/1986	Gosset et al. ....	427/154
4,663,180	5/1987	Podula .....	426/637

4,931,296	6/1990	Shanbhag et al. ....	426/243
4,931,298	6/1990	Shanbhag et al. ....	426/296
4,937,084	6/1990	Julian .....	426/144
5,000,970	3/1991	Shanbhag et al. ....	426/296
5,004,616	4/1991	Shanbhag et al. ....	426/102
5,059,435	10/1991	Sloan et al. ....	426/102
5,084,291	1/1992	Burrows et al. ....	426/441
5,087,467	2/1992	Schwank .....	426/262
5,126,152	6/1992	Feeney et al. ....	426/102
5,141,759	8/1992	Sloan et al. ....	46/102
5,188,859	2/1993	Lodge et al. ....	426/637 X
5,217,736	6/1993	Feeney et al. ....	426/102
5,242,699	9/1993	Bednar et al. ....	426/302
5,279,840	1/1994	Baisier et al. ....	426/102
5,281,432	1/1994	Zallie et al. ....	426/549
5,302,410	4/1994	Calder et al. ....	426/637
5,328,704	7/1994	Ritch .....	426/102
5,393,552	2/1995	Brusacker et al. ....	426/637
5,431,944	7/1995	Melvej .....	426/552
5,464,642	11/1995	Villagran et al. ....	426/439
5,486,369	1/1996	Mason .....	426/321
5,622,741	4/1997	Stubbs et al. ....	426/243
5,648,110	7/1997	Wu et al. ....	426/102

**FOREIGN PATENT DOCUMENTS**

WO 85/01188 3/1985 WIPO .

*Primary Examiner*—Arthur L. Corbin*Attorney, Agent, or Firm*—Marshall, O'Toole, Gerstein,  
Murray & Borun[57] **ABSTRACT**

The present invention provides improved compositions for coating of potato strip products having an as is solids content comprising at least 40% by weight of a hydrolyzed starch characterized by a DE of from 0.2 to 0.8.

**8 Claims, No Drawings**

## PROCESS FOR PREPARING STARCH HYDROLYZATE COATED POTATO PRODUCTS

### BACKGROUND OF THE INVENTION

The present invention relates generally to coated potato products and formulations for coating potato products such as frozen french fries.

Methods for preparing and applying coatings to the outer surfaces of frozen potato products are well known in the art. Murray et al. U.S. Pat. No. 3,597,227 disclose a process in which raw potato strips are coated in a hot aqueous solution of modified gelatinized amylose derived from corn or potato starch. The process is said to produce a finished product which has superior strength and rigidity. Van Patten et al., U.S. Pat. No. 3,751,268 disclose the coating of blanched potato pieces with an ungelatinized unmodified high amylose starch having an amylose content of at least 50 percent. The coated potato strips are deep fat fried during which the starch in the coating is gelatinized.

El-Hag et al. U.S. Pat. No. 4,317,842 discloses the process of dipping blanched potato strips in an aqueous ungelatinized starch slurry to coat the strips, which are next soaked in hot oil to gelatinize the starch in the coating. The strips are then parfried and frozen. The strips may be reheated for consumption by heating in an oven rather than by deep fat frying.

Lenchin et al., WO 85/01188 disclose batters comprising the flour of high amylose corn hybrids for producing microwaveable pre-fried foodstuffs. The use of flours of high amylose corn hybrids is said to provide pre-fried foodstuffs with improved crispness after microwave cooking which otherwise tends to make such products soggy.

Sloan et al., U.S. Pat. Nos. 5,059,435 and 5,141,759 disclose a process for preparing frozen coated potatoes wherein raw potatoes are washed, cut, blanched and partially dehydrated. The cut potatoes are then coated with an aqueous starch slurry comprising 15 to 35% by weight modified ungelatinized potato starch, 2 to 10% by weight modified ungelatinized corn starch, 2 to 10% by weight rice flour and other optional ingredients. The coated potato strips are parfried in oil and then frozen. The frozen strips are prepared for consumption by either finish frying in hot oil, or heating in an oven. The starch coating is said to enhance the holding quality of the ready to consume product and to improve the acceptability of the finished product by increasing the crispness of the outer surface, and helping to maintain the tenderness of the interior of the cut potato. In particular, the potato starch and corn starch are each said to contribute crispness to the coating, and because they are not gelatinized prior to the parfrying step they decrease clumping of the strips during processing. The rice flour is said to provide a desirable tenderness in the finished product.

The Sloan patents teach the use of potato starches which have been modified through known chemical cross-linking processes in order to minimize sticking or clumping of the strips during processing, and coat the potato strips evenly. The Sloan patents disclose as preferred an ungelatinized chemically modified potato starch (K-1010, Penford Corporation, Richland, Wash.) which is crosslinked with

phosphorus oxychloride ( $\text{POCl}_3$ ) at an effective level of 980 ppm. (This starch is characterized by a Brabender Amylograph viscosity of 50–100 BU ("Brabender units") when measured at a 9% starch solids concentration for 15 minutes at 95° C.) A chemically modified ungelatinized comstarch said to be preferred for use in conjunction with the above modified potato starch at a slurry concentration of 2 to 10% by weight is said to be Flojel® 60 (National Starch and Chemical Corp., Bridgewater, N.J.) which is said to contribute crispness to the coating and to produce an optimal result when present in the coating slurry at a concentration of between two and ten percent by weight.

Also of interest to the present application are the disclosures of Calder et al., U.S. Pat. No. 5,302,410 and Brusacker et al., U.S. Pat. No. 5,393,552 which relate to the use of hydrolyzed starch products such as dextrans and maltodextrins as components of aqueous enrobing slurries. Specifically, the patents disclose contacting blanched potato strips with an aqueous solution which contains from 3% to 12% by weight of a hydrolyzed starch product characterized by a DE less than 12 and preferably from about 2 to 10. The patents specifically disclose the use of maltodextrins having a DE of 6 and teach against the use of maltodextrins having DE values greater than 12 because such hydrolyzate products promote undesirable browning of the final product. The patents further teach that concentrations of the starch hydrolyzate products greater than 12% are undesirable because "at higher concentrations the surface of the potato strips become slightly tacky upon finish frying which promotes undesirable clumping of the potato strips."

Of further interest to the present invention is the disclosure of Melvej, U.S. Pat. No. 5,431,944 which discloses a dry batter mix for french fries comprising from about 1.5% to about 9% by weight of a leavening agent and from about 5% to about 40% by weight of a starch blend comprising a high amylose starch, a starch, from about 1% to about 8% by weight dextrin wherein the weight percent in the batter mix is inversely related to the weight percent of the leavening agent, and about 0.1% to about 2% of a food gum. The specification teaches that the batter mix preferably includes about 2% to about 6%, by weight of dextrin and that the dextrin "provides a tender bite and in improved mouthfeel to the reconstituted food product." The patent further teaches that "[t]he particular amount of dextrin included in the batter mix is inversely related to the amount of leavening agent present in the batter mix. Therefore, as the amount of leavening agent in the batter is increased, the amount of dextrin in the batter mix is decreased, and vice versa. The dextrin mitigates the effects of the leavening agent and provides a more tender crispness. However, if too much dextrin is included in the batter mix, the reconstituted food product has a greasy mouthfeel." (Col. 7, lines 18–30).

Despite the many advances in the french fry coating art there nevertheless remains a need for improved enrobing slurries characterized by improved crispness, holding and flavor properties.

### SUMMARY OF THE INVENTION

The present invention provides improved aqueous starch enrobing slurries which provide improved flavor, crispness and other physical properties to coated potato products such

as french fries. As one aspect of the present invention, starch enrobing slurries have been found that provide various improved properties to the resulting french fries which they are used to encoat. Specifically it has been found that unexpected crispness can be obtained in a french fry coating composition by utilizing at least 40% by weight (on an as is solids basis) of a hydrolyzed starch characterized by a DE of from 0.2 to 0.8. This is particularly surprising in light of the teachings of Calder et al., U.S. Pat. No. 5,302,410 and Brusacker et al., U.S. Pat. No. 5,393,552 which teach that higher concentrations of starch hydrolyzate products such as maltodextrins and dextrins will render the surface of the potato strips slightly tacky upon finish frying and promote undesirable clumping of the potato strips. Similarly, Melvej, U.S. Patent No. 5,431,944 teaches that if too much dextrin is included in the batter mix, the reconstituted food product will have a greasy mouthfeel.

Without being bound to a particular theory of the invention, it is believed that elevated levels of starch hydrolyzate products may be successfully used according to the invention to provide improved crispness, texture and mouthfeel properties by virtue of the particular selection of chain length (molecular weight) of the hydrolyzate products. It has been found that starch hydrolyzate products characterized by a DE between about 0.2 and about 0.8 are characterized by a chain length for a given starch type which makes them particularly suitable for coating the potato strips and providing a crisp product with prolonged holding time and desirable organoleptic properties. It has further been found that hydrolyzate products characterized by DE's less than 0.2 which thus have longer chain lengths than the products of the invention and hydrolyzate products characterized by DE's greater than 0.8 which thus have shorter chain lengths than the products of the invention do not provide such desirable properties when they are present at elevated concentrations such as at 40% solids or higher. It is further contemplated that the improved properties provided by the solids making up the starch enrobing slurries of the invention may also be provided when the solids ingredients making up the slurries are applied to potato products in a non-slurry form such as by dusting.

Specifically, the invention provides improved aqueous starch enrobing slurries for coating the outer surface of a potato product having an as is solids content of at least 40% and preferably at least 50% by weight of a hydrolyzed starch characterized by a DE of from 0.2 to 0.8. "As is solids content" refers to the amount of solids present in typical commercially available potato starch which is not bone dry but typically comprises 12% to 16% water by weight. For the purposes of this invention "as is solids content" refers to a solids content for a starch assuming a water concentration of 14% by weight.

The hydrolyzed starch component of the starch enrobing slurry is preferably characterized by a DE of from about 0.2 to about 0.8. The hydrolyzed starch may be selected from the group including but not limited to hydrolyzed corn, waxy corn, potato, wheat, and tapioca starches with corn and potato starch hydrolyzate products being particularly preferred although hydrolyzed tapioca starches having a DE of 0.19 have been found to be particularly suitable for use according to the invention.

The invention further provides frozen potato products with a film-like coating on the outer surface and processes for their preparation, which processes comprise the steps of: cutting the raw potatoes; blanching the potatoes; partially drying the potatoes; coating the potatoes with an aqueous starch slurry, the starch slurry having an as is solids content comprising at least 40% by weight of a hydrolyzed starch characterized by a DE of from 0.2 to 0.8; par-frying the potatoes in hot oil; and freezing the potatoes.

The invention further provides a process for preparing an aqueous starch enrobing slurry for coating the outer surface of a potato product, which comprises forming an aqueous slurry having an as is solids content comprising at least 40% by weight of a hydrolyzed starch characterized by a DE of from 0.2 to 0.8. All ingredients stated herein are based on dry ingredients as 100%, with 100% to 400%, preferably 120% to 300% water added based upon dry ingredients to make the batter slurry.

#### DETAILED DESCRIPTION

Processes for the production of frozen french fries are well known and include the basic steps of preparing raw potatoes by washing, peeling and cutting into appropriately shaped pieces. The resulting potato strips are then blanched according to conventional methods in order to inactivate enzymes in the potato and to leach sugars from the surface of the potato strip. According to one preferred method, the blanched potato strips are treated in a brine solution comprising components such as sodium chloride, dextrose and other ingredients known to the art. After these steps, the potato strips are then subjected to a drying step to reduce the moisture present in the strips.

The strips are then coated with the aqueous starch enrobing slurry of the invention having an as is solids content comprising at least 40% by weight of a hydrolyzed starch characterized by a DE of from 0.2 to 0.8. After blending of the solid ingredients with a desired amount of water to produce the french fry batter, the batter may be applied to coat the cut potato strips at a batter pickup of from about 8% to about 30% with a pickup of from 13% to about 18% being preferred and a coating pickup of about 15% being particularly preferred, (based on coated potato strips weight).

After coating with the coating composition, the potato strips are drained and par-fried at a temperature of from about 360° F. to about 390° F. for a time period of from 40 seconds to about 90 seconds. Par-frying serves to gelatinize the starch of the potato strips and of the coating and removes moisture from the inside of the potato strip.

The potato strips are then frozen, packaged and preferably stored at a temperature below 0° F. until they are prepared for final consumption. In order to prepare the potato strips for consumption, they are cooked either by finish frying or by baking in an oven. After such preparation, potato strips prepared according to the invention are characterized by a crisp outer layer, a moist tender interior and improved flavor qualities compared to those prepared with coating compositions comprising corn starch components.

Minor amounts of pregelled potato starches are preferably used in the compositions of the invention to provide viscosity control and suspension of the solids in the batter.

Specifically, the aqueous slurry may have an as is solids content of up to about 5% by weight of an unmodified pregelged potato starch for viscosity control. One preferred pregelged potato starch for such use is available commercially as PenPlus® 40 (Penwest Foods Co., Englewood, Colo.) which is preferably incorporated into the batter composition at a solids concentration of 1% to 5% by weight.

The starch enrobing slurry of the invention may also comprise a rice flour component which is preferably present at a solids concentration of from about 10% to about 25% by weight with concentrations of from about 15% to about 20% by weight (as is solids basis) being preferred. Greater concentrations of rice flour tend to make the final coated french fry products too tough while lower concentrations provide products with too little crispness. Rice flours suitable for use with the invention include long grain, medium grain or waxy rice with long grain rice flour being preferred. Long grain rice provides the best results for crispness, because of its higher amylose content in the starch. Use of medium grain rice flour tends to give a tough bite to the batter coating and waxy rice flour provides a hard crunch immediately after frying but the batter coating becomes soft and chewy within ten minutes after frying.

A variety of other flours and starches may optionally be used in producing the coating formulations of the invention including but not limited to potato flour, wheat flour, wheat starch, oat flour, oat starch, tapioca starch, corn flour and corn starch. Such starches may be crosslinked and/or substituted such as by acetylation or other means.

Optional ingredients for use in providing the coating compositions of the invention include microcrystalline cellulose, hydroxypropyl methyl cellulose and gums which are used to provide improved structure and keeping qualities to the coated french fry products. Suitable gums include guar and xanthan gums.

Leavening agents in the form of baking powders may also be incorporated into the compositions of the invention in order to open up the structure of the coating batters upon cooking and release moisture from the french fry products without blowing off the coating layer. Suitable baking powders include sodium bicarbonate plus one or more leavening acids such as those in the group consisting of sodium aluminum phosphate (SALP), sodium aluminum sulfate (SAS), sodium acid pyrophosphate (SAPP), dicalcium phosphate (DCP), and anhydrous monocalcium phosphate (AMCP). The combination of sodium bicarbonate and SALP is preferred because of its bland flavor and slower action. SAPP and DCP give off-flavor in the coating and AMCP reacts too fast during mixing of the batter. Such leavening agents are preferably added at sodium bicarbonate concentrations of about 0.2 to 2.0%.

Additional ingredients include protein components such as sodium caseinate, nonfat dry milk, soy, whey, dried egg whites. Such proteins interact with the carbohydrates in the coating compositions to increase film strength, provide structure, improve crispness and prolong holding of crispness. Milk proteins perform better than egg whites or soy proteins in performing such functions. Other ingredients include carbohydrate components such as methyl cellulose, hydroxypropyl methyl cellulose, microcrystalline cellulose

and the like. Still other optional ingredients may also be incorporated into the coating formulations of the invention including salt, flavorings, seasonings and coloring agents such as whey or dextrose. A particularly preferred dextrose product is available commercially as Cantab® (Penwest Foods Co., Englewood, Colo.).

The french fry coating composition is prepared by dry blending of the various solid ingredients. The dry ingredients are then slowly added to an amount of water selected to provide an appropriate viscosity to the coating batter. It has been found that aqueous slurries containing from about 150 parts to about 300 parts by weight water to 100 parts by weight of the solid ingredients are characterized by a preferred viscosity for coating of the potato strips. The enrobing batter is then preferably applied to potato strips at a batter pickup of 13% to 18% by weight. Because the starches remain ungelatinized during the coating process they do not substantially contribute to the viscosity of the solution.

The crispness of the batter coated french fries is determined by several factors including the cook-out of the starch, the moisture balance between the batter coating surface and inside of the fries, the thickness of the coating layer, and the interaction of ingredients in the coating formulation. The coating forms a dry, discontinuous film, which lets the moisture from the inside of the fries escape or vent out, but will not absorb the moisture into the coating layer. Controlling moisture migration is important to maintaining the crispness of the fries under a heat lamp. The coating should preferably be somewhat brittle, which gives a clean bite with minimum toughness. There is a fine balance between all the ingredients in the batter formula to achieve crispness and keeping quality with the method used to process the potato strips contributing to the crispness of the french fries.

Other aspects and advantages of the present invention will be understood upon consideration of the following illustrative and comparative examples.

#### EXAMPLE 1

According to this example, potato strips were prepared according to conventional methods and coated with various starch slurries comprising starch hydrolyzate products (maltodextrins) characterized by different DEs using the ingredients listed in Table 1 below.

Specifically, Russet-Burbank potatoes were peeled, cut into 1/2 inch strips and immersed and blanched in hot water for 4 to 8 minutes at 170–180° F. After blanching, the potato strips were immersed for 30 seconds in an aqueous solution comprising 0.5% SAPP which was held at a temperature of 160–170° F. After removal, the strips were drained and then dried in a conventional dryer at 190° F., for a sufficient length of time to effectuate a 12 to 20 percent water loss.

Starch slurries were then prepared comprising the ingredients listed in Table 1 including water at about 50° F. The water and dry ingredients were placed in a mixing bowl and mixed with a paddle for three minutes at low speed and one minute at medium speed with the batter temperature maintained at below 65° F. The potato strips were then dipped in the starch slurries and held at 65° F. The potato strips were then drained for 60 seconds to remove excess slurry and to

achieve a slurry coating pickup of 15%. The strips were then parfried in soy oil for 50 seconds at 385° F. The potato strips were then frozen in a blast freezer for 30 minutes, transferred into plastic bags and kept in the same freezer overnight at approximately 0° F. The frozen samples were reconstituted by frying at 360° F for 2.5 minutes. The resulting french fries were then placed under heat 5 lamps, and evaluated for color, bite, crispness, taste and holding time.

The resulting products were then tested to evaluate their properties including the degree of crispness (1 being the poorest and 6 being the best), and the time period for which they maintained their crispness with the results presented in Table 1. The results of evaluation of those batters show that

the starch enrobing slurries produced from potato starch hydrolyzates characterized by DE values greater than 0.8 were characterized by poor crispness, short holding times, fries sticking together and other poor organoleptic properties. In contrast, those batters comprising starch hydrolyzate products characterized by having DEs between 0.2 and 0.8 provided improved crispness, longer heat lamp holding times of 15 or 20 minutes and superior organoleptic properties in the absence of corn starch. In particular, those batters comprising potato starch hydrolyzates with a DE of 0.76 provided significantly improved properties to the french fries to which they were applied compared with those coated with batters having higher DE levels.

TABLE 1

POTATO STARCH HYDROLYZATES (DE 0-6)					
INGREDIENTS	DE	Percent by weight of total solids:			
Hydrolyzed Potato Starch (Staley, StaSlim-143)	0.34	57.59			
Hydrolyzed Potato Starch	0.76		57.59		
Hydrolyzed Potato Starch	1.87			57.59	
Hydrolyzed Potato Starch (Avebe MD-6)	4.59				57.59
Crosslinked Potato Starch (900 ppm)		12.75	12.75	12.75	12.75
Pregelged crosslinked (213 ppm) Potato Starch		1.52	1.52	1.52	1.52
(Penwest, PenPlus-40)					
Guar Gum Blend		0.11	0.11	0.11	0.11
SAPP#28		1.17	1.17	1.17	1.17
Soda		0.96	0.96	0.96	0.96
Salt		4.79	4.79	4.79	4.79
Rice Flour		21.11	21.11	21.11	21.11
Total		100	100	100	100
Crispness at 15 Minutes		5	5.5	4	3

40

## EXAMPLE 2

According to this example, potato strips were prepared and evaluated according to the method of example 1 but wherein corn starch hydrolyzates characterized by a range of DE values were used in the enrobing slurry. The results reported in Table 2 are consistent with those of example 1 in that the best product was that produced with a corn maltodextrin characterized by a DE value of 0.33. Those products produced with comparable batters which differed only with respect to the DE of the corn starch hydrolyzate all had inferior properties compared to those of the invention. Thus, the product comprising a corn hydrolyzate with a DE of 0.08 had unsatisfactory crispness results while those products comprising corn hydrolyzates of DE 1 and higher had unsatisfactory to very poor results.

TABLE 2

CORN STARCH HYDROLYZATES (DE 0-6) RANGE USING CORN STARCH					
INGREDIENTS	DE	Percent by weight of total solids:			
Hydrolyzed Corn Starch	0.08	56.19			
Hydrolyzed Corn Starch	0.33		56.19		
Hydrolyzed Corn Starch (Staley, Star Dri #1)	1			56.19	

TABLE 2-continued

CORN STARCH HYDROLYZATES (DE 0-6) RANGE USING CORN STARCH						
INGREDIENTS	DE	Percent by weight of total solids:				
Hydrolyzed Corn Starch (Grain Processing M-040)	6.27	56.19				
Hydrolyzed Corn Starch (Staley, Star Dri #10)	9.0-10.0	56.19				
Crosslinked Potato Starch (900 ppm)		12.75	12.75	12.75	12.75	12.75
Pregelld crosslinked (213 ppm) Potato Starch (Penwest, PenPlus-40)		2.92	2.92	2.92	2.92	2.92
Guar Gum Blend		0.22	0.22	0.22	0.22	0.22
SAPP#28		1.17	1.17	1.17	1.17	1.17
Soda		0.96	0.96	0.96	0.96	0.96
Salt		4.79	4.79	4.79	4.79	4.79
Rice Flour		21	21	21	21	21
Total		100	100	100	100	100
Crispness at 15 Minutes		4	5	3.5	3.5	1.5

## EXAMPLE 3

According to this example, potato strips were prepared and evaluated according to the method of example 1 using a preferred hydrolyzed corn product (Sta-Slim 143) characterized by a DE of 0.34 wherein the percent of total solids provided by the corn starch hydrolyzate was varied. The results shown in Table 3 show that good properties tend to occur at starch hydrolyzate solids concentrations of 40% by weight and greater with particularly superior properties occurring at solids concentrations of 60% by weight and greater.

TABLE 3

CONCENTRATION TESTING OF HYDROLYZED POTATO STARCH (DE 0.34)					
INGREDIENT	Percent by weight of total solids				
Hydrolyzed Potato Starch (Staley, Sta-slim 143 (DE 0.34))	30	40	50	60	70
Crosslinked Potato Starch 800 ppm	40	30	20	10	0
Pregelld crosslinked (213 ppm) Potato Starch (Penwest, PenPlus-40)	1.7	1.7	1.7	1.7	1.7

20

TABLE 3-continued

CONCENTRATION TESTING OF HYDROLYZED POTATO STARCH (DE 0.34)					
INGREDIENT	Percent by weight of total solids				
Maltodextrin DE = 4	2.4	2.4	2.4	2.4	2.4
SAPP#28	1.6	1.6	1.6	1.6	1.6
Soda	1.3	1.3	1.3	1.3	1.3
Salt	4	4	4	4	4
Rice Flour	19	19	19	19	19
Total	100	100	100	100	100
Crispness at 15 Minutes	4	4.5	4.5	5	5.5

25

30

35

## EXAMPLE 4

According to this example, potato strips were prepared and evaluated according to the method of example 1 using a preferred hydrolyzed corn product (Sta-Slim 143) characterized by a DE of 0.34 wherein the batter solids concentration was varied from 30% by weight to 42% by weight. The results shown in Table 4 show that optimum product properties tend to occur at batter solids concentrations of 39% to 42%.

TABLE 4

BATTER SOLIDS TESTING OF HYDROLYZED POTATO STARCH (DE = 0.34)					
	Percent by weight of total solids				
	30%	33%	36%	39%	42%
Hydrolyzed Potato Starch (Staley, Sta-Slim 143 (DE 0.34))	54.01	55.6	56.6	57.36	57.88
Crosslinked Potato Starch 800 ppm	12.45	12.82	13.04	13.22	13.34
Guar Gum	0.02	0.02	0.02	0.02	0.02
SAPP#28	1.12	1.15	1.17	1.19	1.2
Soda	0.92	0.95	0.97	0.98	0.99
Salt	4.61	4.74	4.83	4.89	4.94
Rice Flour	20.2	20.78	21.15	21.44	21.63
Pregelld crosslinked (213 ppm)	6.67	3.94	2.22	0.9	0
Potato Starch (Penwest, PenPlus-40)					
Total	100	100	100	100	100
Batter Solids	30%	33%	36%	39%	42%
Crispness at 15 Minutes	4	4	4.5	5	5



## 11

Numerous modifications and variations in the practice of the invention are expected to occur to those skilled in the art upon consideration of the presently preferred embodiments thereof. Consequently, the only limitations which should be placed upon the scope of the invention are those which appear in the appended claims.

What is claimed is:

1. A process for preparing a frozen potato product with a film-like coating on the outer surface, which comprises:

cutting raw potatoes;

blanching the raw potatoes;

partially drying the blanched potatoes;

coating the partially dried potatoes with an aqueous starch slurry having an as is solids content comprising at least 40% by weight of a hydrolyzed starch characterized by a DE of from 0.2 to 0.8;

parfrying the coated potatoes in hot oil; and

freezing parfried the potatoes.

## 12

2. The process of claim 1 wherein the aqueous starch slurry is characterized by an as is solids content of at least 50% by weight of said hydrolyzed starch.

3. The process of claim 1 wherein said hydrolyzed starch is characterized by a DE of from 0.3 to 0.5.

4. The process of claim 1 wherein the hydrolyzed starch is selected from the group consisting of corn and potato starches.

5. The process of claim 1 wherein the aqueous starch slurry further comprises a crosslinked starch.

6. The process of claim 1 wherein rice flour is present in the aqueous starch slurry at from 15% to 20% by weight.

7. A coated potato product produced according to the method of claim 1.

8. A fried potato product having a coating comprising an as is solids content of at least 40% by weight of a hydrolyzed starch characterized by a DE of from 0.2 to 0.8.

\* \* \* \* \*

## EXHIBIT 4

PRIOR ART

BATTER FORMULA

INGREDIENT	%
Modified Food Starch	53.70
Hylon VII Cornstarch	5.00
Maltrin M250 Corn Syrup Solids	0.25
SAPP 28	1.00
Sodium Bicarbonate	0.70
Rhodigel Xanthan Gum	0.10
Melojel Cornstarch	5.00
Pregel 10 Wheat Starch	0.50
Crisp Film Cornstarch	4.00
National 0280 Dextrin	8.00
Flour Salt	3.75
Rice Flour	18.00
TOTAL	100.00

## EXHIBIT 5



US006022569A

**United States Patent** [19]

Rogols et al.

[11] **Patent Number:** **6,022,569**[45] **Date of Patent:** **Feb. 8, 2000**[54] **PROCESS FOR PREPARING A STARCH  
COATED POTATO PRODUCT AND  
PRODUCT THEREOF**[75] Inventors: **Saul Rogols, Golden; John Harold  
Woerman, Highlands Ranch; Wallace  
H. Kunerth, Kildeer, all of Colo.**[73] Assignee: **Penford Corporation, Bellevue, Wash.**[21] Appl. No.: **08/912,086**[22] Filed: **Aug. 15, 1997**[51] Int. Cl.<sup>7</sup> ..... **A23L 1/216**[52] U.S. Cl. .... **426/102; 426/302; 426/637**[58] Field of Search ..... **426/102, 637,  
426/302**[56] **References Cited****U.S. PATENT DOCUMENTS**

Re. 27,531	12/1972	Murray et al. .	
3,424,591	1/1969	Gold .....	426/441
3,597,227	8/1971	Murray et al. .	
3,751,268	8/1973	Van Patten et al. .	
4,272,553	6/1981	Bengtsson et al. ....	426/241
4,317,842	3/1982	El-Hag .....	426/302
4,418,090	11/1983	Bohrmann et al. ....	426/578
4,447,459	5/1984	Balboni et al. ....	426/441
4,504,509	3/1985	Bell et al. ....	426/548
4,529,607	7/1985	Lenchin et al. ....	426/94
4,542,030	9/1985	Haury et al. ....	426/262
4,551,340	11/1985	El-Hag et al. ....	426/438
4,595,597	6/1986	Lenchin et al. ....	426/555
4,632,848	12/1986	Gosset et al. ....	427/154
4,663,180	5/1987	Padula .....	426/637
4,931,296	6/1990	Shanbhag et al. ....	426/243
4,931,298	6/1990	Shanbhag et al. ....	426/296
4,937,084	6/1990	Julian .....	426/144
5,000,970	3/1991	Shanbhag et al. ....	426/296

5,004,616	4/1991	Shanbhag et al. ....	426/102
5,059,435	10/1991	Sloan et al. ....	426/102
5,084,291	1/1992	Burrows et al. ....	426/441
5,087,467	2/1992	Schwank .....	426/262
5,126,152	6/1992	Feeney et al. ....	426/102
5,141,759	8/1992	Sloan et al. ....	426/102
5,188,859	2/1993	Lodge et al. ....	426/637 X
5,217,736	6/1993	Feeney et al. ....	426/102
5,242,699	9/1993	Bednar et al. ....	426/302
5,279,840	1/1994	Baisier et al. ....	426/102
5,281,432	1/1994	Zallie et al. ....	426/549
5,302,410	4/1994	Calder et al. ....	426/637
5,328,704	7/1994	Ritch .....	426/102
5,393,552	2/1995	Brusacker et al. ....	426/637
5,431,944	7/1995	Malvej .....	426/552
5,464,642	11/1995	Villagran et al. ....	426/439
5,486,369	1/1996	Mason .....	426/321
5,622,741	4/1997	Stubbs et al. ....	426/243
5,648,110	7/1997	Wu et al. ....	426/102
5,897,898	4/1999	Rogols et al. ....	426/102

**FOREIGN PATENT DOCUMENTS**

WO 85/01188 3/1985 WIPO .

**OTHER PUBLICATIONS**Srivastava, H.C. and Patel, M.M., "Viscosity Stabilization of Tapioca Starch," *Starke*, 25(1):17-21 (1973).*Primary Examiner*—Arthur L. Corbin  
*Attorney, Agent, or Firm*—Marshall, O'Toole, Gerstein,  
Murray & Borun[57] **ABSTRACT**

The present invention provides an aqueous starch enrobing slurry for coating the outer surface of a potato product having an as is solids content comprising ungelatinized starch and not less than 50% by weight rice flour, the method of preparing the potato product and the coated potato product produced thereby.

**9 Claims, No Drawings**

# PROCESS FOR PREPARING A STARCH COATED POTATO PRODUCT AND PRODUCT THEREOF

## BACKGROUND OF THE INVENTION

The present invention relates generally to coated potato products and formulations for coating potato products such as frozen french fries.

Methods for preparing and applying coatings to the outer surfaces of frozen potato products are well known in the art. Murray et al. U.S. Pat. No. 3,597,227 disclose a process in which raw potato strips are coated in a hot aqueous solution of modified gelatinized amylose derived from corn or potato starch. The process is said to produce a finished product which has superior strength and rigidity. Van Patten et al., U.S. Pat. No. 3,751,268 disclose the coating of blanched potato pieces with an ungelatinized unmodified high amylose starch having an amylose content of at least 50 percent. The coated potato strips are deep fat fried during which the starch in the coating is gelatinized.

El-Hag et al. U.S. Pat. No. 4,317,842 discloses the process of dipping blanched potato strips in an aqueous ungelatinized starch slurry to coat the strips, which are next soaked in hot oil to gelatinize the starch in the coating. The strips are then parfried and frozen. The strips may be reheated for consumption by heating in an oven rather than by deep fat frying.

Lenchin et al., WO 85/01188 disclose batters comprising the flour of high amylose corn hybrids for producing microwaveable pre-fried foodstuffs. The use of flours of high amylose corn hybrids is said to provide pre-fried foodstuffs with improved crispness after microwave cooking which otherwise tends to make such products soggy.

Sloan et al., U.S. Pat. Nos. 5,059,435 and 5,141,759 disclose a process for preparing frozen coated potatoes wherein raw potatoes are washed, cut, blanched and partially dehydrated. The cut potatoes are then coated with an aqueous starch slurry comprising 15 to 35% by weight modified ungelatinized potato starch, 2 to 10% by weight modified ungelatinized corn starch, 2 to 10% by weight rice flour and other optional ingredients. The coated potato strips are parfried in oil and then frozen. The frozen strips are prepared for consumption by either finish frying in hot oil, or heating in an oven. The starch coating is said to enhance the holding quality of the ready to consume product and to improve the acceptability of the finished product by increasing the crispness of the outer surface, and helping to maintain the tenderness of the interior of the cut potato. In particular, the potato starch and corn starch are each said to contribute crispness to the coating, and because they are not gelatinized prior to the parfrying step they decrease clumping of the strips during processing. The rice flour is said to provide a desirable tenderness in the finished product.

The Sloan patents teach the use of potato starches which have been modified through known chemical cross-linking processes in order to minimize sticking or clumping of the strips during processing, and coat the potato strips evenly. The Sloan patents disclose as preferred an ungelatinized chemically modified potato starch (K-1010, Penford Corporation, Richland, WA) which is crosslinked with phosphorus oxychloride ( $\text{POCl}_3$ ) at an effective level of 980 ppm. (This starch is characterized by a Brabender Amylograph viscosity of 50–100 BU ("Brabender units") when measured at a 9% starch solids concentration for 15 minutes at 95° C.) A chemically modified ungelatinized cornstarch said to be preferred for use in conjunction with the above modified

potato starch is said to be Flojel® (National Starch and Chemical Corp., Bridgewater, N.J.) which is said to contribute crispness to the coating and to produce an optimal result when present in the coating slurry at a concentration of between two and ten percent by weight.

Also of interest to the present application is the disclosure of co-owned U.S. Pat. No. 5,648,110 which discloses use of potato starches with selected crosslinking levels as preferred components of starch enrobing slurries. Specifically, the patent discloses that potato strips coated with an aqueous starch enrobing slurry having an as is solids content comprising not less than about 50% by weight of ungelatinized crosslinked potato starch characterized by a viscosity of from 200 to 1100 Brabender Units (BU) when measured at 9% solids concentration after 15 minutes at 95° C. (which corresponds to a crosslinking level of from 550 to 900 ppm using  $\text{POCl}_3$ ) and from 10 to 25% by weight rice flour provide improved crispness and texture properties. Also of potential interest to the present application is co-owned and copending U.S. patent application Ser. No. 08/822,031 filed Mar. 24, 1997, now abandoned which is a continuation-in-part of U.S. Pat. No. 5,648,110 and discloses the use of not less than about 50% by weight of ungelatinized crosslinked potato starch characterized by a viscosity of from 200 to 1100 Brabender Units and up to 45% by weight rice flour provided improved crispness properties. Also of potential interest to the present application is co-owned U.S. Pat. No. 5,750,168 the disclosure of which is hereby incorporated by reference which is directed to starch enrobing slurries having a solids content comprising not less than 20% by weight ungelatinized crosslinked tapioca starch characterized by a crosslinking level of from 300 to 1000 ppm. The patent teaches the incorporation of rice flour as a component of the enrobing slurries at solids contents preferably ranging from 10% to 25%.

Despite the many advances in the french fry coating art there nevertheless remains a need for improved enrobing slurries characterized by improved crispness, holding and flavor properties.

## SUMMARY OF THE INVENTION

The present invention provides improved aqueous starch enrobing slurries which provide improved flavor, crispness and other physical properties to coated potato products such as french fries. As one aspect of the present invention, starch enrobing slurries have been found that provide various improved properties to the resulting french fries which they are used to encoat. Specifically it has been found that unexpected crispness can be obtained in a french fry coating composition by utilizing an aqueous starch enrobing slurry having an as is solids content comprising ungelatinized starch and not less than 50% or more preferably 60% or 70% rice flour. It has been found that the use of such slurries comprising elevated levels of rice flour in combination with ungelatinized starches provides surprisingly improved properties to the coated french fries. The ungelatinized starch may be selected from any of the wide variety of starches known to the art including modified, unmodified and derivative starches including potato starch, corn starch, tapioca starch, wheat starch. According to one aspect of the invention tapioca starch is particularly preferred for use as the ungelatinized starch. According to another aspect of the invention, unmodified or slightly modified potato starch having a crosslinking level of less than 400 ppm based on crosslinking with  $\text{POCl}_3$  is particularly preferred as the ungelatinized starch.

The ungelatinized starches useful for practice with the invention may be crosslinked but need not be. While the

starches can be crosslinked according to any of a variety of methods known to the art, starches crosslinked with an agent selected from the group consisting of phosphorus oxychloride, sodium trimetaphosphate/tetrametaphosphate, adipic anhydride and epichlorohydrin are particularly preferred. Contrary to the teachings of the prior art, enrobing slurries incorporating modified potato starches having greater than about 400 ppm crosslinking based on crosslinking with  $\text{POCl}_3$  generally require an additional crisping agent such as a dextrin or the like. Surprisingly, enrobing slurries incorporating ungelatinized potato starches which are unmodified or are modified but have a crosslinking level of less than 400 ppm do not generally require use of additional crisping agents. Thus, the invention further provides an aqueous starch enrobing slurry for coating the outer surface of a potato product having an as is solids content comprising: ungelatinized, modified or unmodified potato starch having a crosslinking level of less than 400 ppm starch and not less than 35% rice flour.

The invention further provides processes for preparing a frozen potato product with a film-like coating on the outer surface and the products so produced, which comprises: cutting the raw potatoes; blanching the potatoes; partially drying, the potatoes; coating the potatoes with the aqueous starch slurries of the invention; followed by parfrying the potatoes in hot oil; and freezing the potatoes.

The invention further provides a dry batter mix for coating the outer surface of a potato product having an as is solids content comprising ungelatinized starch and not less than 50% rice flour and methods of producing such a dry batter mix comprising blending ungelatinized starch and not less than 50% rice flour. For the purposes of this invention "as is solids content" refers to a solids content for a starch assuming a water concentration of about 12% by weight.

#### DETAILED DESCRIPTION

Processes for the production of frozen french fries are well known and include the basic steps of preparing raw potatoes by washing, peeling and cutting into appropriately shaped pieces. The resulting potato strips are then blanched according to conventional methods in order to inactivate enzymes in the potato and to leach sugars from the surface of the potato strip. According to one preferred method, the blanched potato strips are treated in a brine solution comprising components such as sodium chloride, dextrose and other ingredients known to the art. After these steps, the potato strips are then subjected to a drying step to reduce the moisture present in the strips.

The strips are then coated with the aqueous starch enrobing slurry of the invention having an as is solids content comprising ungelatinized starch and rice flour. After blending of the solid ingredients with a desired amount of water to produce the french fry batter, the batter may be applied to coat the cut potato strips at a batter pickup of from about 8% to about 30% with a pickup of from 18% to about 22% being preferred and a coating pickup of about 20% being particularly preferred, (based on coated potato strips weight).

After coating with the coating composition, the potato strips are drained and parfried at a temperature of from about 360° F. to about 390° F. for a time period of from 40 seconds to about 90 seconds. Parfrying serves to gelatinize the starch of the potato strips and of the coating and removes moisture from the inside of the potato strip.

The potato strips are then frozen, packaged and preferably stored at a temperature below 0° F. until they are prepared for final consumption. In order to prepare the potato strips

for consumption, they are cooked either by finish frying or by baking in an oven. After such preparation, potato strips prepared according to the invention are characterized by a crisp outer layer, a moist tender interior and improved flavor qualities.

Minor amounts of modified pregelled potato starches may be used in the compositions of the invention to provide viscosity control and suspension of the solids in the batter. Specifically, preferred aqueous slurries may have an as is solids content of up to about 5% by weight of an unmodified pregelled potato starch for viscosity control. One preferred modified pregelled potato starch for such use is available commercially as PenPlus® 40 (213 ppm crosslinked) (Penwest Foods Co., Englewood, Colo.) which can be incorporated into the batter composition at preferred solids concentrations of 1% to 5% by weight.

The modified starches used in practice of the invention may be crosslinked with any of a variety of agents according to methods well known to the art but are preferably crosslinked with phosphorus oxychloride under alkaline conditions. Sodium trimetaphosphate is useful for crosslinking but reacts more slowly than does phosphorus oxychloride and accordingly substantially more reagent is required to achieve the same level of crosslinking as would be achieved with phosphorus oxychloride. Adipic anhydride is also useful as a crosslinking agent but reacts even more slowly than does sodium trimetaphosphate. Less preferably, epichlorohydrin may also be used at equivalent levels of crosslinking.

Different starches having different levels of crosslinking, and thus exhibiting different viscosities, may be used together in practice of the invention. For example, one modified starch having a crosslinking level of 400 ppm and characterized by a relatively high viscosity may be used in conjunction with another modified starch having a crosslinking level of 1000 ppm and characterized by a relatively low viscosity to yield a blend of modified starches characterized by a crosslinking level and having a viscosity intermediate between those of the two components. It is noted that United States Food and Drug Administration regulations prohibit the use in food products of starches having greater than 1000 ppm  $\text{POCl}_3$  crosslinking (based on dry weight of starch solids.) Thus, other starches which are crosslinked at concentrations too high or too low and thus are characterized by viscosities inappropriate for use alone in practice of the invention can be used in conjunction with other starches provided that the overall starch component is characterized by a viscosity within the desired range.

The method for determining the viscosity of ungelatinized starches for use according to the invention utilizes a Brabender Amylograph viscometer according to conventional methods known to the art as set out below. Specifically, 45.0 grams of "dry basis" starch (to yield 13.5% solids) is placed in a beaker to which distilled water is added to make up 450 grams and is mixed thoroughly with a magnetic stirring bar. The pH of the mixture is adjusted to 7.0 with dilute (approximately 0.5%) NaOH or dilute (approx. 0.5%) HCl. The pH should be determined over a period of 5 to 10 minutes and should be measured both before and after the viscometer run. The starch slurry is then added to the viscometer bowl and the beaker rinsed with distilled water to give a total starch and water weight of 500 grams. The Brabender Amylograph is then run on program 2 comprising a starting temperature of 25° C., a heating rate of 1.5° C./minute to 95° C., running at 95° C. for 15 minutes wherein the measurement is taken at the conclusion of 15 minutes in Brabender units (BU), and cooling at 1.5° C./minute to 50° C.

Rice flours suitable for use with the invention include long grain, medium grain, short grain or waxy rice with long grain rice flour being preferred. Long grain rice provides the best results for crispness, because of its higher amylose content in the starch. Nevertheless, medium grain, short grain and waxy rice flours work well according to the present invention. This is surprisingly the case with waxy rice flour which in applications such as that of U.S. Pat. No. 5,648,110 was said to produce french fries having a hard crunch immediately after frying but which became soft and chewy within ten minutes of frying.

A variety of other flours and starches may optionally be used in producing the coating formulations of the invention including but not limited to potato starch, potato flour, wheat flour, wheat starch, oat flour, oat starch, corn flour and corn starch. Such starches may be crosslinked and/or substituted such as by acetylation or other means.

Optional minor ingredients for use in providing the coating compositions of the invention include maltodextrins, dextrans, microcrystalline cellulose, and hydrocolloids including hydroxypropyl methyl cellulose, and gums including xanthan gum, guar gum and the like which are used to provide improved structure and keeping qualities to the coated french fry products. Maltodextrins are preferably used at solids concentrations of up to 6%. Maltodextrins useful with the invention may be derived from any type of starch including tapioca, potato and corn starch and include those characterized by having a DE in the range from 2 to 7 with maltodextrins having a DE of about 5 being preferred.

Dextrins obtained from a variety of sources may also be used according to the invention. Suitable tapioca dextrins that may be used according to the invention include those commercially available as Crisp Coat® and Crisp Coat UC® (National Starch and Chemical Co.) which comprise tapioca dextrin alone or in combination with high amylose corn starch. Preferred gum blends comprise approximately 10% gum by weight and are preferably incorporated into the compositions of the invention at solids concentrations of less than 0.1% gum by weight.

Leavening agents in the form of baking powders may also be incorporated into the compositions of the invention in order to open up the structure of the coating batters upon cooking and release moisture from the french fry products without blowing off the coating layer. Suitable baking powders include sodium bicarbonate plus one or more leavening acids such as those in the group consisting of sodium aluminum phosphate (SALP), sodium aluminum sulfate (SAS), sodium acid pyrophosphate (SAPP), dicalcium phosphate (DCP), and anhydrous monocalcium phosphate (AMCP). The combination of sodium bicarbonate and SAPP is preferred. Such leavening agents are preferably added at sodium bicarbonate concentrations of about 0.9 parts soda to 1.1 parts SAPP.

Additional ingredients include protein components such as sodium caseinate, nonfat dry milk, soy, whey, dried egg whites. Such proteins interact with the carbohydrates in the coating compositions to increase film strength, provide structure, improve crispness and prolong holding of crispness. Other ingredients include carbohydrate components such as methyl cellulose, hydroxypropyl methyl cellulose, microcrystalline cellulose and the like. Still other optional ingredients may also be incorporated into the coating formulations of the invention including salt, flavorings, seasonings and coloring agents such as whey or dextrose.

The french fry coating composition is prepared by dry blending of the various solid ingredients. Water is then

slowly added to the dry ingredients in an amount selected to provide an appropriate viscosity to the coating batter. It has been found that aqueous slurries containing from about 150 parts to about 300 parts by weight water to 100 parts by weight of the solid ingredients are characterized by a preferred viscosity for coating of the potato strips. The ungelatinized starches do not substantially contribute to the viscosity of the solution.

The crispness of the batter coated french fries is determined by several factors including the cook-out of the starch, the moisture balance between the batter coating surface and inside of the fries, the thickness of the coating layer, and the interaction of ingredients in the coating formulation. The coating forms a discontinuous film which lets the moisture from the inside of the fries escape or vent out, but will not absorb significant amounts of moisture into the coating layer. Controlling moisture migration is important to maintaining the crispness of the fries under a heat lamp. The coating should preferably be somewhat brittle, which gives a clean bite with minimum toughness. There is a fine balance between all the ingredients in the batter formula to achieve crispness and keeping quality with the method used to process the potato strips (contributing to the crispness of the french fries). It is further contemplated that the improved properties provided by the solids making up the starch enrobing slurries of the invention may also be provided when the solids ingredients making up the slurries are applied to potato products in a non-slurry form such as by dusting.

Other aspects and advantages of the present invention will be understood upon consideration of the following illustrative and comparative examples.

#### EXAMPLE 1

According to this example, different levels of three different types of rice flour, long grain, short/medium grain and waxy, were substituted for a crosslinked potato starch (780 ppm crosslinking) in a representative enrobing composition with the results shown in Table 1 below.

Specifically, Russet-Burbank potatoes were peeled, cut into 9/32 inch strips and immersed and blanched in hot water for 4 to 8 minutes at 165–180° F. After blanching, the potato strips were immersed for 30 seconds in an aqueous solution comprising 0.5% SAPP 28 and 1.5% salt which was held at a temperature of 160–170° F. After removal, the strips were drained and then dried in a conventional dryer at 190° F., for a sufficient length of time to effectuate a 12 to 20 percent water loss.

Starch slurries were then prepared comprising the ingredients listed in Table 1 including water. The water is added to the dry ingredients and well mixed using a wire whisk. The potato strips were then dipped in the starch slurries. The potato strips were then drained to remove excess slurry and to achieve a slurry coating pickup about 18–22%, preferably 20%. The strips were then parfried in soy oil for 40 seconds at 385° F. The potato strips were then frozen in a blast freezer for 30 minutes, transferred into plastic bags and kept in a freezer overnight at approximately –30° F. The frozen samples were reconstituted by frying at 360° F. for 2.5 minutes. The resulting french fries were then placed under heat lamps, and evaluated for color, bite, crispness, taste and holding time.

The resulting products were then tested to evaluate their properties including the degree of crispness (1 being the poorest and 6 being the best), and the time period for which they maintained their crispness with the results reported in



Table 1. Also presented are scores of roughness (1 being the poorest, i.e., very tough and 6 being the best, i.e. not tough); color with 0 being lighter and higher numbers being darker; and oil content in % by weight. The results show that even in the absence of dextrin as a crisping agent that crispness generally improved as the level of rice flour increased up to 75% by weight. Such results are unexpected in the absence of a dextrin component to promote crispness.

TABLE 1

INGREDIENTS	1A %	1B %	1C %	1D %	1E %	1F %
Rice Flour	0	15	30	45	60	75
Crosslinked Potato Starch (780 ppm)	82.2	67.2	52.2	37.2	22.2	7.5
Crosslinked Potato Starch (980 ppm)	10	10	10	10	10	10
Crosslinked Potato Starch (250 ppm)	1.1	1.1	1.1	1.1	1.1	1.1
Methocel K4M	0.3	0.3	0.3	0.3	0.3	0.3
Salt	5	5	5	5	5	5
SAPP#28	0.8	0.8	0.8	0.8	0.8	0.8
Soda	0.6	0.6	0.6	0.6	0.6	0.6
Total	100	100	100	100	100	100
<u>EVALUATIONS</u>						
<u>Long Grain Rice Flour</u>						
CRISPINESS						
5 min.	4.5	5.5	5	5	4.5	4.5
10 min.	3.8	4.8	4.5	4.5	4	3.8
15 min.	3.5	4	4	4	3.5	3
20 min.	3	3.5	3.5	3	3	2.5
ROUGHNESS						
COLOR	4	4	4	4	4	4
OIL	0	0	0	0.5	0.5	1
<u>Short/Medium Grain Rice Flour</u>						
CRISPINESS						
5 min.	4	4	4.5	5	5	5
10 min.**	3.5	3.5	4	4.5	5	5
15 min.	3	3	3.5	4	4	4
20 min.	2	2	3	3	3.5	3.5
ROUGHNESS						
COLOR	4	4	4	4	4	4
OIL	0	0	0	0	0.2	0.5
<u>Waxy Rice Flour</u>						
CRISPINESS						
5 min.	4.5	4.5	4.5	4.5	5	5
10 min.	4	4	4	4	5	5
15 min.	3.5	3.5	3.5	3.5	4.5	4.5
20 min.	3	3	3	3	4	4
ROUGHNESS						
COLOR	4	4	4	4	4	4
OIL	7.07	6.35	6.35	7.7	7.81	7.27

\*\*Very soft centers after 10 min.

## EXAMPLE 2

According to this example, the general method of Example 1 was repeated in which different levels of three different types of rice flour, long grain, short/medium grain and waxy, were substituted for crosslinked tapioca starch (650 ppm crosslinking) in a representative enrobing composition. The results reported in Table 2 below show that optimum crispness and other properties were achieved at rice flour levels of 30 to 60% in the absence of a dextrin crisping component with long grain rice flour providing the best results.

TABLE 2

INGREDIENTS	2A %	2B %	2C %	2D %	2E %	2F %
Rice Flour	0	15	30	45	60	75
Crosslinked Tapioca Starch (650 ppm)	82.2	67.2	52.2	37.2	22.2	7.5
Crosslinked Potato Starch (980 ppm)	10	10	10	10	10	10
Crosslinked Potato Starch (250 ppm)	1.1	1.1	1.1	1.1	1.1	1.1
Methocel K4M	0.3	0.3	0.3	0.3	0.3	0.3
Salt	5	5	5	5	5	5
SAPP#28	0.8	0.8	0.8	0.8	0.8	0.8
Soda	0.6	0.6	0.6	0.6	0.6	0.6
Total	100	100	100	100	100	100
<u>EVALUATIONS</u>						
<u>Long Grain Rice Flour</u>						
CRISPINESS						
5 min.	4.8	5	5	5.5	5.5	5
10 min.	4.5	4.5	5	5.5	5.5	5
15 min.	4	4	4.5	5.5	5.5	5
20 min.	3.5	3.5	4	5.5	5.5	5
ROUGHNESS						
COLOR	4	4	4	4	4	3
OIL	0	0	0.2	0.5	0.5	1
<u>Short/Medium Grain Rice Flour</u>						
CRISPINESS						
5 min.	4.8	4.8	5.5	5.5	5.5	5
10 min.	4.5	4.5	5.5	5.5	5.5	5
15 min.	4	4	5.5	5.5	5.5	4.5
20 min.	3.5	3.5	5	5	5	4
ROUGHNESS						
COLOR	4	4	4	4	4	4
OIL	0.5	0.5	0.5	0.5	0.5	0.5
<u>Waxy Rice Flour</u>						
CRISPINESS						
5 min.	5	5	5.5	5.5	5.5	5
10 min.	4.8	4.8	5.5	5.5	5.5	5
15 min.	4	4.5	5.5	5.5	5.5	4.5
20 min.	3.5	4	5	5	5	4
ROUGHNESS						
COLOR	4	4	4	4	4	4
OIL	0.5	0.5	0.5	1	1.5	1.5
OIL	7.11	7.97	7.72	9.73	8.15	8.09

## EXAMPLE 3

According to this example, the general method of Example 1 was repeated in which different levels of three different types of rice flour, long grain, short/medium grain and waxy, were substituted for crosslinked corn starch (650 ppm crosslinking) in a representative enrobing composition. The results shown in Table 3 below show that optimum crispness and other properties were achieved at rice flour levels of 30 to 60% in the absence of a dextrin crisping component with long grain rice flour providing the best results.

TABLE 3

INGREDIENTS	3A %	3B %	3C %	3D %	3E %	3F %
Rice Flour	0	15	30	45	60	75
Crosslinked Corn Starch (650 ppm)	82.2	67.2	52.2	37.2	22.2	7.5
Crosslinked Potato Starch (980 ppm)	10	10	10	10	10	10
Crosslinked Potato Starch (250 ppm)	1.1	1.1	1.1	1.1	1.1	1.1

TABLE 3-continued

INGREDIENTS	3A %	3B %	3C %	3D %	3E %	3F %
Methocel K4M	0.3	0.3	0.3	0.3	0.3	0.3
Salt	5	5	5	5	5	5
SAPP#28	0.8	0.8	0.8	0.8	0.8	0.8
Soda	0.6	0.6	0.6	0.6	0.6	0.6
Total	100	100	100	100	100	100
<u>EVALUATIONS</u>						
<u>Long Grain Rice Flour</u>						
<u>CRISPINESS</u>						
5 min.	5.5	5.5	5	5.5	5.5	5.5
10 min.	5.2	5.2	5	5.5	5.5	4.8
15 min.	4.5	4.5	4.5	5	5	4.5
20 min.	4	4	4	4.5	4.5	4
<u>ROUGHNESS</u>						
COLOR	4	4	4	4	4	4
OIL	0.5	0.5	0.5	0.5	0.8	0.8
OIL	6.44	6.92	6.77	7.64	7.59	7.75
<u>Short/Medium Grain Rice Flour</u>						
<u>CRISPINESS</u>						
5 min.	5	5	5	5.5	5.5	5
10 min.	4.5	4.5	4.5	5.5	5.5	4.5
15 min.	4	4	4	5	5	4
20 min.	3.5	3.5	3.5	4.5	4.5	3.5
<u>ROUGHNESS</u>						
COLOR	4	4	4	4	4	4
OIL	0	0	0	0	0.2	0.2
OIL	6.84	7.41	6.91	6.62	7.04	7.13
<u>Waxy Rice Flour</u>						
<u>CRISPINESS</u>						
5 min.	5	5.5	5.5	5.5	5.5	5
10 min.	5	5.5	5.5	5.5	5	5
15 min.	4.5	5	5.5	5.5	5	4.5
20 min.	4	5	5.5	5.5	5	4
<u>ROUGHNESS</u>						
COLOR	4	4	4	4	4	4
OIL	0	0	0	0	0.2	0.5
OIL	6.82	7.8	7.55	8.78	8.59	7.61

\*\* Note:  
Compared to tapioca variations, these two respective variations exhibited a very "light" crunchy texture.

## EXAMPLE 4

According to this example, the method of Example 1 was repeated with the results shown in Table 4 below. Those results are generally poorer than those achieved in Example 1.

TABLE 4

INGREDIENTS	4A %	4B %	4C %	4D %	4E %	4F %
Rice Flour	0	15	30	45	60	75
Crosslinked Potato Starch (780 ppm)	82.2	67.2	52.2	37.2	22.2	7.5
Crosslinked Potato Starch (980 ppm)	10	10	10	10	10	10
Crosslinked Potato Starch (250 ppm)	1.1	1.1	1.1	1.1	1.1	1.1
Methocel K4M	0.3	0.3	0.3	0.3	0.3	0.3
Salt	5	5	5	5	5	5
SAPP#28	0.8	0.8	0.8	0.8	0.8	0.8
Soda	0.6	0.6	0.6	0.6	0.6	0.6
Total	100	100	100	100	100	100

TABLE 4-continued

INGREDIENTS	4A %	4B %	4C %	4D %	4E %	4F %
<u>EVALUATIONS</u>						
<u>Long Grain Rice Flour</u>						
<u>CRISPINESS</u>						
5 min.	4	4.5	4.5	4.5	5	4.5
10 min.	3.5	4	4.5	4.5	4.5	4
15 min.	3	3.5	4	4	4	3.5
20 min.	2	3	3	3	3	2
<u>ROUGHNESS</u>						
COLOR	4	4	4	4	4	4
OIL	0	0	0	0	0	0
OIL	6.5	6.5	5.8	5.6	7	6
<u>Short/Medium Grain Rice Flour</u>						
<u>CRISPINESS</u>						
5 min.	4	5	5	5	5	4.5
10 min.	3	4	4.5	4.5	4	3
15 min.	2	3	3.5	3.5	3.5	2
20 min.	1	2	3	3	2	2
<u>ROUGHNESS</u>						
COLOR	4	4	4	4	4	4
OIL	6.1	6.2	5.6	7.6	6.7	7.1
<u>Waxy Rice Flour</u>						
<u>CRISPINESS</u>						
5 min.	4.5	5.5	5.5	5.5	5.5	5
10 min.	3.5	4	4	4	4.5	4
15 min.	3	3.5	3.5	3.5	4	3
20 min.	2	2	3	3	3	1
<u>ROUGHNESS</u>						
COLOR	4	4	4	4	4	4
OIL	7.3	7.1	7.3	6.5	7.1	7.4

## EXAMPLE 5

According to this example, the general method of Example 1 was repeated with slurries comprising long grain rice flour and varying amounts of tapioca dextrin and either highly crosslinked potato starch (780 ppm) (Table 5); a slightly crosslinked potato starch (245 ppm) (Table 6); or an unmodified potato starch (Table 7). The results shown in Tables 5, 6 and 7 below show the utility provided by using a potato starch having a crosslinking level less than, 400 ppm and in particular using unmodified potato starch with rice flour at solids concentrations above 35%.

TABLE 5

EVALUATIONS	5A	5B	5C	5D	5E	5F
<u>CRISPINESS</u>						
5 min.	4.5	4.5	4.5	5	5	5
10 min.	4	4	4	4.5	4.5	4.5
15 min.	3.5	4	4	4	4.5	4.5
20 min.	3	3	3.5	3.5	4.5	4.5
<u>ROUGHNESS</u>						
COLOR	4	4	4	4	4	4
OIL	0	0	0	0	0.5	0.5
OIL	7.4	7.1	7.3	7.7	7.1	7.4
INGREDIENTS	5A %	5B %	5C %	5D %	5E %	5F %
Rice Flour Long Grain	0	0	0	45	45	45
Crosslinked Potato Starch (780 ppm)	80.2	78.2	76.2	35.2	33.2	31.2
0280 Dextrin	2	4	6	2	4	6
Crosslinked Potato Starch (980 ppm)	10	10	10	10	10	10
Crosslinked Potato Starch (250 ppm)	1.1	1.1	1.1	1.1	1.1	1.1

TABLE 5-continued

Methocel K4M	0.3	0.3	0.3	0.3	0.3	0.3
Salt	5	5	5	5	5	5
SAPP #28	0.8	0.8	0.8	0.8	0.8	0.8
Soda	0.6	0.6	0.6	0.6	0.6	0.6
Total	100	100	100	100	100	100

TABLE 6

INGREDIENTS	6A %	6B %	6C %	6D %	6E %	6F %	6G %	6H %	6I %
Rice Flour Long Grain	0	0	0	45	45	45	45	45	45
Crosslinked Potato Starch (245 ppm)	80.2	78.2	76.2	35.2	33.2	31.2	35.2	33.2	31.2
0280 Dextrin	2	4	6	2	4	6	0	0	0
Tapioca Dextrin (Crisp Coat ® UC)	0	0	0	0	0	0	2	4	6
Crosslinked Potato Starch (980 ppm)	10	10	10	10	10	10	10	10	10
Crosslinked Potato Starch (250 ppm)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Methocel K4M	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Salt	5	5	5	5	5	5	5	5	5
SAPP #28	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Soda	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Total	100	100	100	100	100	100	100	100	100
EVALUATIONS	6A	6B	6C	6D	6E	6F	6G	6H	6I
<u>CRISPINESS</u>									
5 min.	4	4.5	4.5	5	5.5	5.5	5.5	5.5	5.5
10 min.	3.5	3.5	4	4	5	5.5	5	5	5.5
15 min.	3	3	3.5	3.5	4	5.5	4	4	5
20 min.	2	2	2.5	2.5	3	5	4	4	5
ROUGHNESS	4	4	4	4	4	4	4	4	4
COLOR	0	0	0	0	0.2	0.2	0.2	1	1
OIL	6.2	5.8	6.2	6.8	6.8	7.1	6.6	6.8	6.9

TABLE 7

[illegible]

TABLE 7-continued

COLOR	0	0	0	0	0	0	0	0	0
OIL	6.4	6.1	6.8	6.8	7.1	6.1	6.5	7.2	7.8

## EXAMPLE 6

According to this example, the general method of Example 1 was repeated utilizing an unmodified potato starch in combination with long grain rice flour and varying amounts of tapioca dextrin and slightly crosslinked (200 ppm) potato starch. The results reported in Table 8 further show that unmodified potato starch in combination with levels of rice flour greater than 35% provide improved crispness results.

TABLE 8

INGREDIENTS	8A %	8B %	8C %	8D %	8E %	8F %	8G %	8H %	8I %
Rice Flour Long Grain	45	45	45	45	45	45	52	53	60.6
Unmod. Pot. St.	35.2	33.2	31.2	29.2	27.2	25.2	7.6	5.6	0
Tapioca Dextrin (Crisp Coat @ UC)	2	4	6	8	10	12	8	10	9
Crosslinked Potato Starch (200 ppm)	0	0	0	0	0	0	14.6	13.6	12.6
Crosslinked Potato Starch (980 ppm)	10	10	10	10	10	10	10	10	10
Crosslinked Potato Starch (250 ppm)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Methocel K4M	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Salt	5	5	5	5	5	5	5	5	5
SAPP #28	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Soda	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Total	100	100	100	100	100	100	100	100	100
EVALUATIONS	8A	8B	8C	8D	8E	8F	8G	8H	8I
<u>CRISPINESS</u>									
5 min.	5.8	5	5.8	5	5.8	5.5	5.5	6	6
10 min.	5.5	5	5.5	5	5.8	5.5	5.5	6	6
15 min.	5	4.5	5.5	4.5	5.8	5	5.5	6	6
20 min.	4	4	5.5	4.5	5.8	4	5	5.5	5.5
ROUGHNESS	4	4	4	4	3	3	3	3	3
COLOR	1	1	1	0.5	1.5	1.5	1.5	2	2
OIL	7.97	7.38	7.79	8.06	8.69	8.92	6.02	6.1	6.06
XL Level	0	0	0	0	0	0	200	200	200

## EXAMPLE 7

According to this example, the general method of Example 1 was repeated utilizing very high levels of long grain, short/medium grain or waxy rice flour in combination with a slightly crosslinked (200 ppm) potato starch. The results reported in Table 9 below show that excellent crispness scores were obtained with the slightly crosslinked potato starch and small amounts of dextrin. In addition, the results showing excellent crispness results for the waxy rice flour are unexpected since waxy rice flour is not known for its ability to function in batter coatings to enhance crispness characteristics. Also unexpected were the low oil uptake levels resembling those in the long grain rice.

TABLE 9

INGREDIENTS	9A %	9B %	9C %	9D %
Rice Flour	70	70	70	80
Tapioca Dextrin (Crisp Coat @ UC)	9	6	3	3
Crosslinked Potato Starch (200 ppm)	13.2	16.2	19.2	9.2

TABLE 9-continued

PenPlus 40	1.1	1.1	1.1	1.1
Methocel K4M	0.3	0.3	0.3	0.3
Salt	5	5	5	5
SAPP #28	0.8	0.8	0.8	0.8
Soda	0.6	.6	0.6	0.6
Total	100	100	100	100
EVALUATION	9A	9B	9C	9D
<u>Long Grain Rice Flour</u> <u>CRISPNESS</u>				
5 min.	6	6	5.3	6
10 min.	6	6	5	6
15 min.	5	5	4	5.5
20 min.	4.5	4.5	3.5	5
ROUGHNESS	3	3	3	4

TABLE 9-continued

COLOR	1.5	1.5	1.5	1.5
OIL	7.3	7.4	7.7	8
<i>Short/Medium Grain Rice Flour</i>				
CRISPNESS				
5 min.	5.5	5.5	5.5	5.5
10 min.	5.5	5.5	5.5	5.5
15 min.	5.5	5.2	5.2	5.5
20 min.	5	5.2	5.2	5.5
ROUGHNESS	2.5	2.5	2.5	2.5
COLOR	1	1	1	1
OIL	7.9	7.5	7	6.9
<i>Waxy Rice Flour</i>				
CRISPNESS				
5 min.	6+	6+	6+	6+
10 min.	6+	6+	6	6+
15 min.	5.5	5.5	5.2	5.5
20 min.	5	5	0	5.5
ROUGHNESS	2.5	2.5	2.5	2.5
COLOR	1	1	1	1
OIL	7	8.3	8.7	8.8

## EXAMPLE 8

According to this example, the general method of Example 7 was repeated utilizing very high levels of long grain, short/medium grain or waxy rice flour in combination with a highly crosslinked (980 ppm) potato starch. The results reported in Table 10 below when compared to those in Table 9 show that when highly crosslinked potato starch is used in the presence of elevated levels of rice flour crispness decreases and oil uptake increases compared with use of the slightly crosslinked (200 ppm) potato starch.

TABLE 10

INGRE- DIENTS	10A %	10B %	10C %	10D %	10E %	10F %	10G %	10H %
Long Grain Rice Flour	70	70	70	80	70	70	70	80
Short/Medium Grain Rice Flour								
Waxy Rice Flour								
Tapioca	9	6	3	3	9	6	3	3
Dextrin (Crisp Coat @ UC)								
Crosslinked Potato Starch (850 ppm)	13.2	16.2	19.2	9.2				
Crosslinked Tapioca Starch (100 ppm)					13.2	16.2	19.2	9.2
Crosslinked Potato Starch (250 ppm)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Methocel K4M	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Salt	5	5	5	5	5	5	5	5
SAPP #28	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Soda	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Total	100	100	100	100	100	100	100	100
EVALUA- TION	10A	10B	10C	10D	10E	10F	10G	10H
CRISPNESS								
5 min.	6	6	6	6	6	6	6	6
10 min.	5.5	5.5	5	5	5	6	6	5.5
15 min.	5	5	5	4	4.5	5	5	5.5

TABLE 10-continued

20 min.	4	4	4	4	4.5	5	4.5	4.5
ROUGHNESS	3	3	3	3	3	3	3	3
COLOR	0.8	0.8	0.8	0.8	1.5	1.5	1.5	1.5
OIL	8.4	8.9	9.2	9	7.6	8.6	8.2	8.5
INGRE- DIENTS	10I %	10J %	10K %	10L %	10M %	10N %	10O %	10P %
Long Grain Rice Flour								
Short/Medium Grain Rice Flour	70	70	70	80				
Waxy Rice Flour					70	70	70	80
Crisp Coat UC	9	6	3	3	9	6	3	3
XC4-9000								
YB39-92	13.2	16.2	19.2	9.2	13.2	16.2	19.2	9.2
PenPlus 40	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Methocel K4M	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Salt	5	5	5	5	5	5	5	5
SAPP #28	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Soda	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Total	100	100	100	100	100	100	100	100
EVALUA- TION	10I	10J	10K	10L	10M	10N	10O	10P
CRISPNESS								
5 min.	6+	6+	6+	5.5	6+	6+	6+	6
10 min.	6	6	6	5	5.5	5	5	5
15 min.	5	5	5	4.5	5.5	4	4	5
20 min.	5	5	4	4	5	4	4	4
ROUGHNESS	2.5	2.5	2.5	2.5	3	3	2.5	2.5
COLOR	1	1	1	1	1	1	1.5	1.5
OIL	6.2	6.8	6.5	6.8	8.4	8.6	9	8.7

Note: "6+" equals a firm, noisy bite with a tender interior; crispy and breaks cleanly after 30 minutes.

## EXAMPLE 9

According to this example, the general method of Example 1 was carried out wherein very high levels of various rice flours were combined with crosslinked tapioca starch (200 ppm) and a tapioca dextrin containing crisping agent (Crisp Coat® UC). The results reported in Table 11 below show excellent crispness results obtained by use of elevated levels of rice flour in combination with the tapioca starch.

TABLE 11

INGREDIENTS	11A %	11B %	11C %	11D %
Rice Flour	70	70	70	80
Tapioca Dextrin (Crisp Coat® UC)	9	6	3	3
Crosslinked Tapioca Starch (200 ppm)	13.2	16.2	19.2	9.2
Crosslinked Potato Starch (250 ppm)	1.1	1.1	1.1	1.1
Methocel K4M	0.3	0.3	0.3	0.3
Salt	5	5	5	5
SAPP #28	0.8	0.8	0.8	0.8
Soda	0.6	0.6	0.6	0.6
Total	100	100	10	100

TABLE 11-continued

EVALUATION	11A	11B	11C	11D
<i>Long Grain Rice Flour</i>				
<u>CRISPNESS</u>				
5 min.	6+	6+	6+	6+
10 min.	6+	6+	6+	6+
15 min.	5.5	5.5	5.5	5.5
20 min.	5	5	5.5	5
ROUGHNESS	3	3	3	3
COLOR	1.5	1.5	1.5	1.5
OIL	8.3	9	9	8.4
<i>Short/Medium Grain Rice Flour</i>				
<u>CRISPNESS</u>				
5 min.	6+	6+	6+	6
10 min.	6+	6+	6	6
15 min.	6+	6+	5	5
20 min.	5.5	5.5	5	4
ROUGHNESS	2.5	2.5	2.5	2.5
COLOR	1.5	1.5	1	1
OIL	7.5	7.7	7.8	8
<i>Waxy Rice Flour</i>				
<u>CRISPNESS</u>				
5 mm.	6+	6+	lost	6+
10 min.	6+	6+	lost	6
15 min.	6+	5.5	lost	6
20 min.	6+	5	lost	6
ROUGHNESS	3	3	lost	2
COLOR	1.5	1.5	lost	1.5
OIL	9.1	8.6	lost	8.6

## EXAMPLE 10

According to this example, the general method of Example 1 was carried out utilizing a lightly crosslinked potato starch (200 ppm) in combination with long grain rice flour treated with varying degrees of 5 oxidation (from 0.2% to 0.8% chlorine, based on weight of chlorine, such as in sodium hypochlorite, to weight of dry starch with the chlorination reaction run substantially to completion) as measured by a negative orthotolidine end point. The results reported in Table 12 show that oxidation of rice flour with increasing levels of chlorine provides improvements in crispness properties. There was no detectable chlorine odor in the batter or finished fries when the rice flour was treated with 0.2% or 0.4% chlorine. At 0.6% chlorine there was detectable chlorine odor in the batter (but not in the finished fries) while at 0.8% there was a strong chlorine odor in both the batter and finished fries.

TABLE 12

INGREDIENTS	12A %	12B %	12C %	12D %
Long Grain Rice Flour	70	70	70	70
—% Chlorine Oxidized				
20% Dextrin (Lykaby)	9	6	3	0
Crosslinked Potato Starch (200 ppm)	13.2	16.2	19.2	22.2
Crosslinked Potato Starch (250 ppm)	1.1	1.1	1.1	1.1
Methocel K4M	0.3	0.3	0.3	0.3
Salt	5	5	5	5
SAPP #28	0.8	0.8	0.8	0.8
Soda	0.6	0.6	0.6	0.6
Total	100	100	100	100

TABLE 12-continued

EVALUATION	12A	12B	12C	12D
<u>0.2% Chlorine</u>				
<u>CRISPNESS</u>				
5 min.	6+	6+	6+	6+
10 min.	5.5	5.5	5.5	5.5
15 min.	5.5	5.5	5.5	5
20 min.	5.5	5.5	5.5	5
ROUGHNESS	2	3.5	3.5	3.5
COLOR	2	2	2	2
OIL	9	8.4	8.3	7.1
<u>0.4% Chlorine</u>				
<u>CRISPNESS</u>				
5 min.	6+	6+	6+	6+
10 min.	6+	6+	6+	6+
15 min.	6+	6+	5	5
20 min.	6+	6	4	4
ROUGHNESS	2	2	2	2
COLOR	2	2	2	2
OIL	8.5	8.5	8.3	8.5
<u>0.6% Chlorine</u>				
<u>CRISPNESS</u>				
5 min.	6+	6+	6+	5.5
10 min.	6+	6+	6+	5
15 min.	5	5	4	4
20 min.	4	4	2	2
ROUGHNESS	2	2	2	2
COLOR	1.5	1.5	1.5	1.5
OIL	7.7	7.4	7.3	7.3
<u>0.8% Chlorine</u>				
<u>CRISPNESS</u>				
5 min.	6+	6+	6+	na
10 min.	5.5	5.5	5	na
15 min.	4.5	4	4	na
20 min.	3	2	2	na
ROUGHNESS	2	2	2	na
COLOR	2	2	2	na
OIL	7.7	7.4	6.5	na

Numerous modifications and variations in the practice of the invention are expected to occur to those skilled in the art upon consideration of the presently preferred embodiments thereof. Consequently, the only limitations which should be placed upon the scope of the invention are those which appear in the appended claims.

What is claimed is:

1. A process for preparing a frozen potato product with a film-like coating on the outer surface which comprises:

cutting the raw potatoes;

blanching the potatoes;

partially drying the potatoes;

coating the potatoes with an aqueous slurry, the slurry having an as is solids content comprising ungelatinized starch and not less than 50% by weight rice flour.

2. The process of claim 1 wherein the starch enrobing slurry has an as is solids content comprising not less than 60% by weight rice flour.

3. The process of claim 1 wherein the starch enrobing slurry has an as is solids content comprising not less than 75% by weight rice flour.

4. The process of claim 1 wherein the ungelatinized starch is selected from the group consisting of potato, corn and tapioca starches.

5. The process of claim 1 wherein the ungelatinized starch is tapioca starch.

6. A coated potato product which is the product of the process of claim 1.

**19**

7. A process for preparing a frozen potato product with a film-like coating on the outer surface which comprises:

cutting the raw potatoes;

blanching the potatoes;

partially drying the potatoes;

coating the potatoes with an aqueous slurry, the slurry having an as is solids content comprising ungelatinized, modified or unmodified potato starch having a

**20**

crosslinking level of less than 400 ppm starch and not less than 35% by weight rice flour.

8. The process of claim 7 wherein the ungelatinized potato starch is unmodified.

9. A coated potato product which is the product of the process of claim 7.

\* \* \* \* \*

## EXHIBIT 6





US006080434A

**United States Patent** [19]**Horn et al.**[11] **Patent Number:** **6,080,434**[45] **Date of Patent:** **Jun. 27, 2000**[54] **FRENCH FRY POTATO PRODUCTS WITH  
IMPROVED FUNCTIONALITY AND  
PROCESS FOR PREPARING**[75] Inventors: **Greg Horn, Littleton; Saul Rogols,**  
Golden, both of Colo.[73] Assignee: **Penford Corporation, Bellevue, Wash.**[21] Appl. No.: **09/108,607**[22] Filed: **Jul. 1, 1998**[51] **Int. Cl.<sup>7</sup>** ..... **A23L 1/216**[52] **U.S. Cl.** ..... **426/102; 426/302; 426/637**[58] **Field of Search** ..... **426/102, 302,**  
426/637[56] **References Cited****U.S. PATENT DOCUMENTS**

3,597,227	8/1971	Murray et al. .	
3,751,268	8/1973	Van Patten et al. .	
4,317,842	3/1982	El-Hag et al. ....	426/302
4,504,509	3/1985	Bell et al. ....	426/549
4,529,607	7/1985	Lenchin et al. ....	426/94
4,595,597	6/1986	Lenchin et al. ....	426/555
5,059,435	10/1991	Sloan et al. ....	426/102

5,141,759	8/1992	Sloan et al. ....	426/102
5,281,432	1/1994	Zallie et al. ....	426/549
5,302,410	4/1994	Calder et al. ....	426/637
5,393,552	2/1995	Busacker et al. ....	426/637
5,431,944	7/1995	Melvej ....	426/552
5,622,741	4/1997	Stubbs et al. ....	426/243
5,648,110	7/1997	Wu et al. ....	426/102
5,750,168	5/1998	Woerman et al. ....	426/102
5,897,898	4/1999	Rogols et al. ....	436/302 X

**FOREIGN PATENT DOCUMENTS**

WO85/01188 3/1985 WIPO .

*Primary Examiner*—Arthur L. Corbin*Attorney, Agent, or Firm*—Marshall, O'Toole, Gerstein,  
Murray & Borun

[57]

**ABSTRACT**

An aqueous starch enrobing slurry, for coating the outer surface of a potato product, having an as is solids content is provided which has at least 30% by weight of a first crosslinked starch, at least 2% by weight of a crosslinked dent corn starch having a crosslinking level of at least 500 ppm and from 5% to 20% by weight dextrin and wherein the crosslinked dent corn starch is preferably acetylated.

**7 Claims, No Drawings**

# FRENCH FRY POTATO PRODUCTS WITH IMPROVED FUNCTIONALITY AND PROCESS FOR PREPARING

## BACKGROUND OF THE INVENTION

The present invention relates generally to coated potato products and formulations for coating potato products such as frozen french fries.

Methods for preparing and applying coatings to the outer surfaces of frozen potato products are well known in the art. Murray et al. U.S. Pat. No. 3,597,227 disclose a process in which raw potato strips are coated in a hot aqueous solution of modified gelatinized amylose derived from corn or potato starch. The process is said to produce a finished product which has superior strength and rigidity. Van Patten et al., U.S. Pat. No. 3,751,268 disclose the coating of blanched potato pieces with an ungelatinized unmodified high amylose starch having an amylose content of at least 50 percent. The coated potato strips are deep fat fried during which the starch in the coating is gelatinized.

El-Hag et al. U.S. Pat. No. 4,317,842 discloses the process of dipping blanched potato strips in an aqueous ungelatinized starch slurry to coat the strips, which are next soaked in hot oil to gelatinize the starch in the coating. The strips are then parfried and frozen. The strips may be reheated for consumption by heating in an oven rather than by deep fat frying.

Lenchin et al., WO 85/01188 disclose batters comprising the flour of high amylose corn hybrids for producing microwaveable pre-fried foodstuffs. The use of flours of high amylose corn hybrids is said to provide pre-fried foodstuffs with improved crispness after microwave cooking which otherwise tends to make such products soggy.

Bell et al., U.S. Pat. No. 4,504,509 disclose batter compositions for potato strips comprising crosslinked high amylose corn starch (Hylon® VII, National Starch and Chemical Corp.) in combination with tapioca dextrin. Lenchin et al., U.S. Pat. Nos. 4,595,597 and 4,529,607 and Zallie et al., U.S. Pat. No. 5,281,432 also disclose the use of high amylose corn starch or acetylated high amylose corn starch in french fry enrobing slurries. While high amylose corn starches can provide certain useful properties to french fry enrobing slurries their practical utility is limited by their expense.

Sloan et al., U.S. Pat. Nos. 5,059,435 and 5,141,759 disclose a process for preparing frozen coated potatoes wherein raw potatoes are washed, cut, blanched and partially dehydrated. The cut potatoes are then coated with an aqueous starch slurry comprising 15 to 35% by weight modified ungelatinized potato starch, 2 to 10% by weight modified ungelatinized corn starch, 2 to 10% by weight rice flour and other optional ingredients. The coated potato strips are parfried in oil and then frozen. The frozen strips are prepared for consumption by either finish frying in hot oil, or heating in an oven. The starch coating is said to enhance the holding quality of the ready to consume product and to improve the acceptability of the finished product by increasing the crispness of the outer surface, and helping to maintain the tenderness of the interior of the cut potato. In particular, the potato starch and corn starch are each said to contribute crispness to the coating, and because they are not gelatinized prior to the parfrying step they decrease clumping of the strips during processing. The rice flour is said to provide a desirable tenderness in the finished product.

The Sloan patents teach the use of potato starches which have been modified through known chemical cross-linking processes in order to minimize sticking or clumping of the strips during processing, and coat the potato strips evenly. The Sloan patents disclose as preferred an ungelatinized

chemically modified potato starch (K-1010, Penford Corporation, Richland, Wash.) which is crosslinked with phosphorus oxychloride ( $\text{POCl}_3$ ) at an effective level of 980 ppm. (This starch is characterized by a Brabender Amylograph viscosity of 50–100 BU ("Brabender units") when measured at a 9% starch solids concentration for 15 minutes at 95° C.) A chemically modified ungelatinized cornstarch said to be preferred for use in conjunction with the above modified potato starch is said to be Flojel® 60 (National Starch and Chemical Corp., Bridgewater, N.J.) which is said to contribute crispness to the coating and to produce an optimal result when present in the coating slurry at a concentration of between two and ten percent by weight.

Also of interest to the present application is the disclosure of Wu, et al. U.S. Pat. No. 5,648,110 which discloses use of potato starches with crosslinking levels which are generally higher than 550 ppm as preferred components of starch enrobing slurries. Further of interest is the disclosure of Woerman, et al. U.S. Pat. No. 5,750,168 which discloses preferred starch enrobing slurries containing crosslinked tapioca starches in combination with tapioca dextrans and high amylose corn starch.

References relating to use of starch hydrolysis products include Calder et al., U.S. Pat. No. 5,302,410 and Brusacker et al., U.S. Pat. No. 5,393,552 which teach the use of hydrolyzed starch products such as dextrans and maltodextrins as components of aqueous enrobing slurries. Specifically, the patents disclose contacting blanched potato strips with an aqueous solution which contains from 3% to 12% by weight of a hydrolyzed starch product characterized by a DE less than 12 and preferably from about 2 to 10. The patents specifically disclose the use of maltodextrins having a DE of 6 and teach against the use of maltodextrins having DE values greater than 12 because such hydrolyzate products build up reducing sugars and promote undesirable browning of the final product. The patents further teach that concentrations of the starch hydrolyzate products greater than 12% are undesirable because "at higher concentrations the surface of the potato strips become slightly tacky upon finish frying which promotes undesirable clumping of the potato strips."

Of further interest to the present invention is the disclosure (hereby incorporated by reference) of co-owned U.S. Pat. No. 5,897,898, which is directed to the finding that unexpected crispness can be obtained in a french fry coating composition by utilizing at least 40% by weight (on an as is solids basis) of a hydrolyzed starch characterized by a DE of from 0.2 to 0.8. This was particularly surprising in light of the teachings of Calder et al., U.S. Pat. No. 5,302,410; and Brusacker et al., U.S. Pat. No. 5,393,552 as discussed above.

Of further interest to the present invention is the disclosure of Melvej, U.S. Pat. No. 5,431,944 which discloses a dry batter mix for french fries comprising from about 1.5% to about 9% by weight of a leavening agent and from about 5% to about 40% by weight of a starch blend comprising a high amylose starch, a starch, from about 1% to about 8% by weight dextrin wherein the weight percent in the batter mix is inversely related to the weight percent of the leavening agent, and about 0.1% to about 2% of a food gum. The specification teaches that the batter mix preferably includes about 2% to about 6%, by weight of dextrin and that the dextrin "provides a tender bite and in improved mouthfeel to the reconstituted food product." The patent further teaches that "[t]he particular amount of dextrin included in the batter mix is inversely related to the amount of leavening agent present in the batter mix. Therefore, as the amount of leavening agent in the batter is increased, the amount of dextrin in the batter mix is decreased, and vice versa. The dextrin mitigates the effects of the leavening agent and provides a more tender crispness. However, if too much

dextrin is included in the batter mix, the reconstituted food product has a greasy mouthfeel." (Col. 7, lines 18-30).

Stubbs et al., U.S. Pat. No. 5,622,741 disclose starch enrobing slurries for potato products comprising the combination of corn flour, dextrins and dent corn starch wherein the dextrins are utilized as fillers. With its emphasis on corn flour the disclosure narrowly defines the modifications that may be made in the enrobing slurry ingredients.

Accordingly, there remains a desire in the art to provide further improvements in the use of dextrin containing enrobing slurries and further to provide improved properties of smoothness, crispness and extended hold time to enrobing slurries. Additionally, there remains a desire in the art to improve or maintain the properties of enrobing slurries while minimizing or eliminating the use of high amylose corn starch.

### SUMMARY OF THE INVENTION

The present invention is directed to coating formulations which provide improved functionality to french fry (potato strip) products. As one aspect of the invention, it has been found that highly crosslinked dent (not high amylose) corn starch generally and acetylated crosslinked dent corn starch in particular provides improved functionality to french fry coating formulations and can be used to replace the presence of more expensive high amylose corn starch in a wide variety of french fry coating formulations. As a further aspect of the present invention it has been found that crosslinked corn starches generally and crosslinked acetylated corn starches specifically are particularly useful for enhancing the functionality of dextrins. In particular, the combination of acetylated crosslinked corn starches into a formulation comprising a first crosslinked starch (such as a potato starch) and a dextrin provides improved crispness to the french fry products coated with that formulation.

Specifically, the invention provides a starch enrobing slurry for coating the outer surface of a potato product and methods for preparing same the slurries having an as is solids content comprising: at least 30% by weight of a first crosslinked starch and at least 2% by weight of a crosslinked dent corn starch characterized by a crosslinking level of at least 500 ppm and a low soluble dextrin at from 5% to 20% by weight with a preferred dextrin as is solids content ranging from 8% to 16% by weight. The crosslinked dent corn starch is preferably present at a dry solids content of from 4% to 12% by weight and is preferably crosslinked at a level of greater than 900 ppm. Most preferably the crosslinked dent corn starch is acetylated. The first crosslinked starch may be selected from the group consisting of potato and tapioca starches but is preferably a crosslinked potato starch. According to a preferred aspect of the invention the crosslinked potato starch is characterized by a crosslinking level of less than 750 ppm and more preferably by a crosslinking level of from 200 ppm to 700 ppm with a crosslinking level of less than 550 ppm and from 300 ppm to 675 ppm being particularly preferred. When the crosslinked potato starch is characterized by a crosslinking level of less than 750 ppm the crosslinked corn starch is preferably characterized by a crosslinking level of equal to or greater than 900 ppm. The first crosslinked starch is more preferably present at a dry solids content of at least 48% by weight.

According to a further aspect of the invention, it has been found that highly crosslinked dent corn starches generally and highly crosslinked acetylated dent corn starches in particular can be used to substitute for the use of some or all of high amylose corn starches in french fry formulations. According to this aspect of the invention, it is believed that the high gelatinization temperature of the highly crosslinked

dent corn starch and not the amylose content provides the critical improved functional characteristic of this ingredient. Thus, the present invention further provides an aqueous starch enrobing slurry for coating the outer surface of a potato product having an as is solids content comprising: at least 30% by weight of a first crosslinked starch (which is preferably crosslinked potato or tapioca starch) and at least 2% (although preferably 4-12% by weight) by weight of a crosslinked dent corn starch characterized by a crosslinking level of at least 500 ppm with higher crosslinking levels being even more preferred. The crosslinked corn starches of the invention are preferably acetylated, characterized by a crosslinking level of greater than 900 ppm and are preferably present at a dry solids content of from 4% to 20% by weight. The crosslinked first starch is preferably crosslinked potato starch. The use of highly crosslinked dent corn starches allows improvements in french fry products comprising potato starches having lower crosslinking levels than would ordinarily provide optimum properties. Lower crosslinked potato starches are known to exhibit a rougher surface on the coated potato strip and pick up more frying oil. Thus, potato starches having crosslinking levels of less than 750 ppm to as low as 200 ppm provide improved coating properties when combined with the highly crosslinked dent corn starch. While the starches can be crosslinked according to any of a variety of methods known to the art, starches crosslinked with an agent selected from the group consisting of phosphorus oxychloride, sodium trimetaphosphate, adipic anhydride and epichlorohydrin are particularly preferred.

The invention further provides processes for preparing a frozen potato product with a film-like coating on the outer surface and the "french fry" products made thereby, which process comprises: cutting the raw potatoes; blanching the raw potatoes; partially drying the blanched potatoes; coating the partially dried potatoes with an aqueous starch slurries according to the invention; and freezing the coated potatoes. According to alternative embodiments such processes may be carried out which further comprise the step of par-frying the coated potatoes prior to freezing.

While the aqueous starch enrobing slurries of the invention may include a variety of additional ingredients particularly preferred slurries are characterized by an as is solids content comprising from 5% to 45% by weight and higher rice flour with rice flour concentrations ranging from 10% to 25% by weight rice flour being preferred.

The present invention provides improved aqueous starch enrobing slurries which provide improved flavor, crispness and other physical properties to coated potato products such as french fries. As one aspect of the present invention, starch enrobing slurries have been found that provide various improved properties to the resulting french fries which they are used to encoat.

### DETAILED DESCRIPTION

Processes for the production of frozen french fries are well known and include the basic steps of preparing raw potatoes by washing, peeling and cutting into appropriately shaped pieces. The resulting potato strips are then blanched according to conventional methods in order to inactivate enzymes in the potato and to leach sugars from the surface of the potato strip. According to one preferred method, the blanched potato strips are treated in a brine solution comprising components such as sodium chloride, dextrose and other ingredients known to the art. After these steps, the potato strips are then subjected to a drying step to reduce the moisture present in the strips.

The strips are then coated with the aqueous starch enrobing slurry of the invention. After blending of the solid

ingredients with a desired amount of water to produce the french fry batter, the batter may be applied to coat the cut potato strips at a batter pickup of from about 8% to about 30% with a pickup of from 13% to about 18% being preferred and a coating pickup of about 15% being particularly preferred, (based on coated potato strips weight).

After coating with the coating composition, the potato strips are drained and parfried at a temperature of from about 360° F. to about 390° F. for a time period of from 40 seconds to about 90 seconds. Parfrying serves to gelatinize the starch of the potato strips and of the coating and removes moisture from the inside of the potato strip.

The potato strips are then frozen, packaged and preferably stored at a temperature below 0° F. until they are prepared for final consumption. In order to prepare the potato strips for consumption, they are cooked either by finish frying or by baking in an oven. After such preparation, potato strips prepared according to the invention are characterized by a crisp outer layer, a moist tender interior and improved flavor qualities compared to those prepared with coating compositions comprising corn starch components.

Minor amounts of modified pregelged potato starches may be used in the compositions of the invention to provide viscosity control and suspension of the solids in the batter. Specifically, preferred aqueous slurries may have an as is solids content of up to about 5% by weight of an unmodified pregelged potato starch for viscosity control. One preferred modified pregelged potato starch used as a viscosifier for such use is available commercially as PenPlus® 40 (213 ppm crosslinked) (Penford Food Ingredients Co., Englewood, Colo.) which can be incorporated into the batter composition at preferred solids concentrations of 1% to 5% by weight.

In addition, it has been found that the viscosity of the crosslinked starches may influence the overall qualities of the coated french fries. While the viscosities of crosslinked starches are generally controlled by the degree to which the starch is crosslinked it is believed that other factors, such as heat annealing may reduce viscosity and increase gelatinization temperatures and can affect the actual viscosity when used according to the invention and measured according to procedure set out below.

The modified starches used in practice of the invention are crosslinked with any of a variety of agents according to methods well known to the art but are preferably crosslinked with phosphorus oxychloride under alkaline conditions. As used herein crosslinking levels refer to levels of crosslinking using phosphorus oxychloride according to conventional methods and its equivalent using other crosslinking agents. Sodium trimetaphosphate is useful for crosslinking as is phosphorus oxychloride. Adipic anhydride is also useful as a crosslinking agent but reacts even more slowly than does sodium trimetaphosphate. Less preferably, epichlorohydrin may also be used at equivalent levels of crosslinking.

Different starches having different levels of crosslinking, and thus exhibiting different viscosities, may be used together in practice of the invention. For example, one modified starch having a crosslinking level of 300 ppm and characterized by a relatively high viscosity may be used in conjunction with another modified starch having a crosslinking level of 1000 ppm and characterized by a relatively low viscosity to yield a blend of modified starches characterized by a crosslinking level and having a viscosity intermediate between those of the two components.

The method for determining the viscosity of crosslinked starches for use according to the invention utilizes a Brabender Amylograph viscometer according to conventional methods known to the art as set out below. Specifically, 45.0 grams of "dry basis" starch (to yield 13.5% solids) is placed

in a beaker to which distilled water is added to make up 450 grams and is mixed thoroughly with a magnetic stirring bar. The pH of the mixture is adjusted to 7.0 with dilute (approximately 0.5%) NaOH or dilute (approx. 0.5%) HCl. The pH should be determined over a period of 5 to 10 minutes and should be measured both before and after the viscometer run. The starch slurry is then added to the viscometer bowl and the beaker rinsed with distilled water to give a total starch and water weight of 500 grams. The Brabender Amylograph is then run on program 2 comprising a starting temperature of 25° C., a heating rate of 1.5° C./minute to 95° C., running at 95° C. for 15 minutes wherein the measurement is taken at the conclusion of 15 minutes in Brabender units (BU), and cooling at 1.5° C./minute to 50° C. Those of skill in the art will recognize that operating the viscometer at alternative conditions will achieve differing results.

The starches of the invention may also be further modified by acetylation or hydroxypropylation but such modification is not necessary for practice of the invention. If the starches are so modified, it is generally necessary to increase the level of crosslinking in order to obtain an equivalent level of viscosity.

The starch enrobing slurries of the invention can optionally comprise a rice flour component at a solids concentration of from about 5% to about 45% (or even as high as 82% according to co-owned U.S. Pat. No. 6,022,569, the disclosure of which is incorporated by reference herein) by weight with concentrations of from about 10% to about 25% by weight (as is solids basis) being preferred. Rice flours suitable for use with the invention include long grain, medium grain or waxy rice with long grain rice flour being preferred. Long grain rice provides the best results for crispness, because of its higher amylose content in the starch. Use of medium grain rice flour tends to give a tough bite to the batter coating and waxy rice flour provides a hard crunch immediately after frying but the batter coating becomes soft and chewy within ten minutes after frying.

A variety of other flours and starches may optionally be used in producing the coating formulations of the invention including but not limited to potato starch, potato flour, wheat flour, wheat starch, oat flour, oat starch, corn flour and corn starch. Such starches may be crosslinked and/or substituted such as by acetylation or other means.

Optional minor ingredients for use in providing the coating compositions of the invention include maltodextrins, dextrins, microcrystalline cellulose, and hydrocolloids including hydroxypropyl methyl cellulose, and gums including xanthan gum, guar gum and the like which are used to provide improved structure and keeping qualities to the coated french fry products. Maltodextrins are preferably used at solids concentrations of up to 4%. Maltodextrins useful with the invention may be derived from any type of starch including tapioca, potato and corn starch and include those characterized by having a DE in the range from 0.2 to 5 with maltodextrins having a DE of less than 2 being preferred as described in co-owned U.S. Pat. No. 5,897,898.

Dextrins obtained from a variety of sources, such as potato, corn and tapioca, may also be used according to the invention with potato dextrins being preferred. Suitable tapioca dextrins that may be used according to the invention include those commercially available as Crisp Coat® and Crisp Coat UC® (National Starch and Chemical Co.) which comprise tapioca dextrin alone or in combination with high amylose corn starch.

Preferred gum blends comprise approximately 10% gum by weight and are preferably incorporated into the compositions of the invention at solids concentrations of less than 0.1% gum by weight.

Leavening agents in the form of baking powders may also be incorporated into the compositions of the invention in

order to open up the structure of the coating batters upon cooking and release moisture from the french fry products without blowing off the coating layer. Suitable baking powders include sodium bicarbonate plus one or more leavening acids such as those in the group consisting of sodium aluminum phosphate (SALP), sodium aluminum sulfate (SAS), sodium acid pyrophosphate (SAPP), dicalcium phosphate (DCP), and anhydrous monocalcium phosphate (AMCP). The combination of sodium bicarbonate and SAPP is preferred. Such leavening agents are preferably added at sodium bicarbonate concentrations of about 0.9 parts soda to 1.1 parts SAPP.

Additional ingredients include protein components such as sodium caseinate, nonfat dry milk, soy, whey, dried egg whites. Such proteins interact with the carbohydrates in the coating compositions to increase film strength, provide structure, improve crispness and prolong holding of crispness. Other ingredients include carbohydrate components such as methyl cellulose, hydroxypropyl methyl cellulose, microcrystalline cellulose and the like. Still other optional ingredients may also be incorporated into the coating formulations of the invention including salt, flavorings, seasonings and coloring agents such as whey or dextrose.

The french fry coating composition is prepared by dry blending of the various solid ingredients. Water is then slowly added to the dry ingredients in an amount selected to provide an appropriate viscosity to the coating batter. It has been found that aqueous slurries containing from about 150 parts to about 300 parts by weight water to 100 parts by weight of the solid ingredients are characterized by a preferred viscosity for coating of the potato strips. The ungelatinized starches do not substantially contribute to the viscosity of the solution.

The crispness of the batter coated french fries is determined by several factors including the cook-out of the starch, the moisture balance between the batter coating surface and inside of the fries, the thickness of the coating layer, and the interaction of ingredients in the coating formulation. These effects are best demonstrated on best quality potatoes. The coating forms a discontinuous film which lets the moisture from the inside of the fries escape or vent out, but will not absorb significant amounts of moisture into the coating layer. Controlling moisture migration is important to maintaining the crispness of the fries under a heat lamp. The coating should preferably be somewhat brittle, which gives a clean bite with minimum toughness. There is a fine balance between all the ingredients in the batter formula to achieve crispness and keeping quality with the method used to process the potato strips contributing to the crispness of the french fries. It is further contemplated that the improved properties provided by the solids making up the starch enrobing slurries of the invention may also be provided when the solids ingredients making up the slurries are applied to potato products in a non-slurry form such as by dusting.

Other aspects and advantages of the present invention will be understood upon consideration of the following illustrative and comparative examples.

#### EXAMPLE 1

According to this example, acetylated and non-acetylated corn starches characterized by various levels of crosslinking were used to replace high amylose corn starch in a standard french fry coating formulation. In the formulation set out in Table 1-1 a 70% high amylose crosslinked corn starch (Hylon® VII, National Starch and Chemical) is used to promote crispness primarily with an added improvement in smoothness in the formulation. Table 1-2 shows the substitution of various other corn starches for the high amylose corn starch as the "test starch ingredient" in Table 1-1.

According to the method of this example, Russet-Burbank potatoes were peeled, cut into 1/32 inch strips and immersed and blanched in hot water for 6 minutes at 165° F. After blanching, the potato strips were immersed for 45 seconds in an aqueous solution comprising 2.4% salt and 0.2% SAPP based on total weight of water which was held at a temperature of 160°-170° F. After removal, the strips were drained and then dried in a conventional forced air oven dryer at 180° F. for a sufficient length of time (about 3 minutes) to effectuate a 12 to 14 percent water loss.

The components of Table 1-1 were dry blended and were hydrated at 40% solids by weight to produce a starch slurry and left to stand for at least 5 minutes before use. The potato strips were then dipped in the starch slurries. The potato strips were then drained for 60 seconds to remove excess slurry and to achieve a slurry coating pickup of 20% based upon original (as is) strip weight. The potato strips were then immediately parfried for 40 seconds at 360° F. The potato strips were then frozen and held overnight before being finished fried and evaluated for crispness and initial smoothness with the results are reported in Table 1-2 with the crispness results measured on a scale of 0-6.0 with 0 being least crisp and 6.0 being most crisp. Smoothness was evaluated on a scale of 0-6.0 with 0 being very rough and 6 being very smooth. The minimum acceptable score for crispness was about 4.0. The results as presented in Table 1-2 show that the products are characterized by high levels of crispness measured on a scale of 0-6.0 with 0 being least crisp and 6.0 being most crisp. The minimum acceptable score for crispness was about 3.0 to 3.5. The resulting products were then tested to evaluate their properties and the time period for which they maintained their crispness.

The results reported in Table 1-2 show that a low swelling starch (in this case the crosslinked dent corn having crosslinking levels greater than about 500 ppm, e.g. Exp. 1H-Exp 1N) may be used to replace high amylose corn starch in french fry coating formulations and in particular that the substitution of highly crosslinked acetylated dent corn starch for high amylose corn starch provides improved crispness and initial smoothness properties to the resulting french fries. Superior crispness is apparent for a 20 minute holding time along with obtaining a smooth finish to the final french fry product.

TABLE 1-1

Ingredients	%
XL potato starch (650 ppm) <sup>1</sup>	54.0
Rice flour - 80 Mesh	21.0
Xanthan gum	0.1
Salt	3.0
SAPP#4	1.0
Soda	0.8
SDE Maltodextrins	0.1
Potato Dextrin (15-20% soluble)	14.0
Test Starch Ingredient	6.0
	100.0

<sup>1</sup>Potato starch crosslinked using 650 ppm phosphorus oxychloride according to conventional methods (Penbind 170, Penford Food Ingredients Co.).

Table 1-2

Exp.	Test Starch	Crispness				Initial Smoothness
		5 min	10 min	15 min	20 min	
1A	High Amylose Corn (Hylon VII)	5.5	5.5	5.0	4.9	4/3

Table 1-2-continued

Exp. Test Starch	Crispness				Initial Smoothness
	5 min	10 min	15 min	20 min	
1B Uncrosslinked Dent Corn	5.0	4.0	4.0	3.5	4
1C Uncrosslinked Dent Corn	5.0	4.5	4.0	3.0	3.5/4
1D XL (150 ppm) Dent Corn	5.5	5.0	4.0	3.5	4/3
1E XL (150 ppm) Dent Corn	5.5	5.0	4.5	4.5	4
1F XL (300 ppm) Dent Corn	5.5	5.0	4.5	3.5	4/3
1G XL (300 ppm) Dent Corn	5.5	5.5	5.0	4.5	4
1H XL (550 ppm) Dent Corn	5.5	5.5	5.5	5.5	5
1I XL (550 ppm) Dent Corn	5.5	5.0	5.0	5.0	4.8
1J XL (980 ppm) Dent Corn	5.5++	5.5++	5.5+	5.5+	6
1K XL (980 ppm) Dent Corn	5.5+	5.5+	5.5	5.5	5
1L Acetylated (4%) XL (980 ppm) Potato	5.5++	5.5++	5.5+	5.5+	6
1M Acetylated (4%) XL (980 ppm) Potato	5.5+	5.5+	5.5+	5.5+	6
1N Acetylated (4%) XL (980 ppm) Corn	5.5	5.5	5	4.5	4/3

## EXAMPLE 2

According to this example, the method of example 1 is repeated wherein potato strip coating formulations are prepared comprising the components of Table 2-1 wherein the test ingredient is present at higher concentrations. The test results reported in Table 2-2 confirm that the crosslinked dent corn having crosslinking levels greater than about 500 ppm may be used to replace high amylose corn starch in french fry coating formulations and in particular that the substitution of highly crosslinked acetylated dent corn starch for high amylose corn starch provides improved crispness and initial smoothness properties to the resulting french fries.

TABLE 2-1

Ingredients	%
XL potato starch (650 ppm)	54.0
Rice flour - 80 Mesh	21.0
Xanthan gum	0.1
Salt	3.0
SAPP#4	1.0
Soda	0.8
SDE Maltodextrins	0.1
Potato Dextrin (15-20% soluble)	9.0
Test Starch Ingredient	11.0
	100.0

TABLE 2-2

Exp. Test Starch	Crispness				Initial Smoothness
	5 min	10 min	15 min	20 min	
2A High Amylose Corn (Hylon VII)	5.5	5.5	5.0	5.0	5
2B Uncrosslinked Dent Corn	5.5	4.5	4.0	3.0	4
2C XL (150 ppm) Dent Corn	5.5	5.0	4.5	4.5	4
2D Acetylated (5%) XL (150 ppm) Dent Corn	5.5	5.0	4.5	4.0	4.8
2E XL (300 ppm) Dent Corn	5.5	5.5	5.0	4.5	4
2F XL (550 ppm) Dent Corn	5.5	5.5	5.0	5.0	4
2G Acetylated (5%) XL (550 ppm) Dent Corn	5.5	5.5	5.5	5.5	6+
2H XL (980 ppm) Dent Corn	5.5	5.5	5.5	5.5	5.5
2I Acetylated (5%) XL (980 ppm) Dent Corn	5.5	5.5	5.5	5.5	6

## EXAMPLE 3

According to this example, crosslinked dent corn starch was used to enhance the properties of dextrins in french fry coating formulations. Specifically, enrobing slurries were prepared according to the method of example 1 using the formulations described in Table 3 below. French fries were then produced and evaluated as described above with the results reported in Table 3. These results show that crosslinked acetylated dent corn starch has the ability to enhance the crispness properties provided by dextrins. The results also show that highly crosslinked non-acetylated corn also has the ability to enhance the crispness properties of coated french fries. In addition, the results show that the combination of a low crosslinked (200 ppm) potato starch as a primary film forming starch with crosslinked corn starch as a secondary low gelling starch and a low solubility dextrin yields a smooth, crisp french fried potato product and that the use of the three components in combination provides improvements over the use of those ingredients individually and lowers the effective cross linking level required for the crosslinked potato starch as the primary starch.

TABLE 3

Ingredients	3A %	3B %	3C %	3D %	3E %	3F %	3G %	3H %
650 ppm XL potato	—	—	48	46	46	46	46	—
200 ppm XL potato	46.1	48	—	—	—	—	—	48
Xanthan gum	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Salt	5	5	5	5	5	5	5	5
SAPP#4	1.0	1.1	1.1	0.9	0.9	0.9	0.9	1.1
Soda	1.2	0.9	0.9	0.7	0.7	0.7	0.7	0.9
Rice flour - 30 mesh	25	24	24	24.5	24.5	24.5	24.5	24.5
Potato dextrin	15.5	—	—	11.9	11.9	11.9	21.5	—
Tapioca dextrin	—	12	12	—	—	—	—	20.8
980 ppm XL Acetylated	6.0	8.8	—	10.8	—	—	—	—

TABLE 3-continued

Ingredients	3A %	3B %	3C %	3D %	3E %	3F %	3G %	3H %
(5%) Corn 980 ppm XL corn 300 ppm XL Corn 908 ppm XL Acetylated (4%) Potato Evaluation Crispness	—	—	—	—	10.8	—	—	—
5 min	5.5	5.5+	5.5	5.5	5.5	5.5	5.0	5.0
10 min	5.5	5.5+	5.0	5.5	5.5	4.5	5.0	5.0
15 min	5.0	5.5+	4.5	5.5	5.3	4.5	4.0	4.5
20 min	5.0	5.5+	4.5	5.5	5.3	4.2	4.0	4.5
Initial Smoothness	4.5	5.5	4.5	5.5	5.5	5.5	4.5	4.5

## EXAMPLE 4

According to this example, crosslinked dent corn starches characterized by different levels of acetylation were tested as the secondary low swelling starch in french fry enrobing slurries to determine the optimum level of acetylation. Specifically, french fry enrobing slurries were prepared according to the method of Example 1 using the formulation of Table 4-1. The resulting slurries were used to coat french fry products which were then evaluated according to that example. The results reported in Table 4-2 show that optimum acetylation levels for this particular experiment range from 2% to 4% with 3-4% providing the best results.

TABLE 4-1

Ingredients	%
XL (650 ppm) potato starch	48
XL (980 ppm) acetylated (x %) potato starch*	8.8
Xanthan gum	.2
Salt	5
SAPP 4	1.1
Soda	.9
Rice flour - 80 mesh	24
Tapioca dextrin	12

TABLE 4-2

Sample	Acetylation %	Crispness				Initial Smoothness
		5 min	10 min	15 min	20 min	
4A	1	5.5	4.5	4.0	3.8	4.5
4B	2	5.5	5.5	5.5	5.0	6
4C	3	5.5	5.5	5.5	5.5	6
4D	4	5.5	5.5	5.5	5.5	6
4E	5	5.5	5.0	4.5	4.5	5

## EXAMPLE 5

According to this example, a comparison was made between various french fry enrobing formulations comprising various substitutions of crosslinked (650 ppm) potato starch, highly crosslinked (980 ppm) dent corn starch and low soluble dextrin into a basic french fry formulation having as its primary components unmodified potato starch and rice flour. Specifically, french fry enrobing slurries were

prepared according to the methods of Example I using the formulations of Table 5. The resulting slurries were used to coat french fry products which were then evaluated according to the methods of that example. The results reported in Table 5 show that the combination of crosslinked potato starch as a primary film forming starch with highly crosslinked dent corn starch as a secondary low swelling starch and potato dextrin as a low soluble dextrin provide significantly improved crispness and smoothness results over the use of those three components individually or in other combinations.

TABLE 5

Ingredients	5A %	5B %	5C %	5D %
650 ppm XL Potato Starch	46	—	—	—
Rice Flour 80 Mesh	24.5	24.5	24.5	24.5
Xanthan Gum	0.2	0.2	0.2	0.2
Salt	5	5	5	5
SAPP #4	0.9	0.9	0.9	0.9
Soda	0.7	0.7	0.7	0.7
980 ppm XL Corn Starch	10.8	10.8	10.8	—
Potato Dextrin	11.9	11.9	11.9	—
Potato Starch, Unmodified	—	46	56.8	68.7
Total Evaluation Crispness	100	100	100	100
5 min.	5.5	4.0	3.0	3.0
10 min.	5.5	3.0	3.0	3.0
15 min.	5.5	2.5	2.0	2.0
20 min.	5.5	2.5	1.5	1.0
Initial Smoothness	6.0	4.0	4.0	3.0

## EXAMPLE 6

According to this example, an evaluation was made of two french fry enrobing formulations not within the scope of the invention comprising either unmodified potato starch or unmodified dent corn starch as their primary film forming starch. Specifically, french fry enrobing slurries were prepared according to the methods of Example 1 using the formulations of Table 6. The resulting slurries were used to coat french fry products which were then evaluated according to the methods of that example. The results reported in Table 6 when compared to those of the preceding examples show that the use of unmodified starches as the primary film forming starches without the presence of secondary low swelling starches such as highly crosslinked dent corn starch and low soluble dextrans provide poor properties to the resulting french fry products.

TABLE 6

Ingredients	6A %	6B %
Unmodified Potato Starch	70	—
Unmodified Corn Starch	—	70
Rice Flour	20.75	20.75
Xanthan Gum	0.5	0.5
PenPlus 40	1.20	1.20
Salt	5.0	5.0
SAPP #28	1.6	1.6
Soda	1.4	1.4
Total Evaluation	100	100

TABLE 6-continued

Ingredients	6A %	6B %
<u>Crispness</u>		
5 min.	5.0	4.0
10 min.	4.5	4.0
15 min.	3.0	3.0
20 min.	1.5	2.0
Initial Smoothness	3.0	3.0

Numerous modifications and variations in the practice of the invention are expected to occur to those skilled in the art upon consideration of the presently preferred embodiments thereof. Consequently, the only limitations which should be placed upon the scope of the invention are those which appear in the appended claims.

What is claimed is:

1. A process for preparing a frozen potato product with a film-like coating on the outer surface, which comprises:
  - cutting the raw potatoes;
  - blanching the raw potatoes;
  - partially drying the blanched potatoes;
  - coating the partially dried potatoes with an aqueous starch slurry having an as is solids content comprising at least 30% by weight of a first crosslinked starch, at least 2% by weight of a second crosslinked starch consisting of crosslinked dent corn starch having a crosslinking level of at least 500 ppm and from 5% to 20% by weight dextrin; and

freezing the coated potatoes.

2. The process of claim 1 wherein said dextrin is a potato dextrin.

3. A coated potato product produced according to the method of claim 1.

4. A process for preparing a frozen potato product with a film-like coating on the outer surface, which comprises:

cutting the raw potatoes;

blanching the raw potatoes;

10 partially drying the blanched potatoes;

coating the partially dried potatoes with an aqueous starch slurry having an as is solids content comprising at least 30% by weight of a first crosslinked starch and at least 2% by weight of a second crosslinked starch consisting of crosslinked dent corn starch having a crosslinking level of at least 500 ppm; and

freezing the coated potatoes.

5. A coated potato product produced according to the method of claim 4.

6. A frozen potato product having a coating, said coating comprising an as is solids content of at least 30% by weight of a first crosslinked starch, at least 2% by weight of a second crosslinked starch consisting of crosslinked dent corn starch having a crosslinking level of at least 500 ppm and from 5% to 20% by weight dextrin.

7. A frozen potato product having a coating, said coating comprising an as is solids content of at least 30% by weight of a first crosslinked starch, and at least 2% by weight of a second crosslinked starch consisting of crosslinked dent corn starch having a crosslinking level of at least 500 ppm.

\* \* \* \* \*



## EXHIBIT 7



US006159521A

**United States Patent** [19]**Horn et al.**[11] **Patent Number:** **6,159,521**[45] **Date of Patent:** **Dec. 12, 2000**[54] **DENT CORN STARCH ENROBING SLURRY**[75] Inventors: **Greg Horn**, Littleton; **Saul Rogols**,  
Golden, both of Colo.[73] Assignee: **Penford Corporation**, Bellevue, Wash.[21] Appl. No.: **09/557,842**[22] Filed: **Apr. 26, 2000**

4,595,597	6/1986	Lenchin et al.	426/555
5,059,435	10/1991	Sloan et al.	426/102
5,141,759	8/1992	Sloan et al.	426/102
5,281,432	1/1994	Zallie et al.	426/549
5,302,410	4/1994	Calder et al.	426/637
5,393,552	2/1995	Busacker et al.	426/637
5,431,944	7/1995	Melvej	426/552
5,622,741	4/1997	Stubbs et al.	426/243
5,648,110	7/1997	Wu et al.	426/102
5,750,168	5/1998	Woerman et al.	426/102
5,897,898	4/1999	Rogols et al.	426/102

**Related U.S. Application Data**[62] Division of application No. 09/108,607, Jul. 1, 1998, Pat.  
No. 6,080,434.[51] Int. Cl.<sup>7</sup> ..... **A21D 10/04**; **A23L 1/0522**[52] U.S. Cl. .... **426/549**; **426/550**; **426/653**;  
426/661[58] Field of Search ..... **426/549**, **550**,  
426/653, 661[56] **References Cited****U.S. PATENT DOCUMENTS**

3,597,227	8/1971	Murray et al.	
3,751,268	8/1973	Van Patten et al.	
4,317,842	3/1982	El-Hag et al.	426/302
4,505,509	3/1985	Bell et al.	426/459
4,529,607	7/1985	Lenchin et al.	426/94

**FOREIGN PATENT DOCUMENTS**

WO85/01188 3/1985 WIPO.

*Primary Examiner*—Arthur L. Corbin*Attorney, Agent, or Firm*—Marshall, O'Toole, Gerstein,  
Murray & Borun[57] **ABSTRACT**

An aqueous starch enrobing slurry, for coating the outer surface of a potato product, having an as is solids content which is characterized by at least 30% by weight of a first crosslinked starch, at least 2% by weight of a crosslinked dent corn starch having a crosslinking level of at least 500 ppm and from 5% to 20% by weight dextrin, and wherein the crosslinked dent corn starch is preferably acetylated.

**19 Claims, No Drawings**

## DENT CORN STARCH ENROBING SLURRY

This is a divisional of U.S. application Ser. No. 09/108,607, filed Jul. 1, 1998, now U.S. Pat. No. 6,080,434.

## BACKGROUND OF THE INVENTION

The present invention relates generally to coated potato products and formulations for coating potato products such as frozen french fries.

Methods for preparing and applying coatings to the outer surfaces of frozen potato products are well known in the art. Murray et al. U.S. Pat. No. 3,597,227 disclose a process in which raw potato strips are coated in a hot aqueous solution of modified gelatinized amylose derived from corn or potato starch. The process is said to produce a finished product which has superior strength and rigidity. Van Patten et al., U.S. Pat. No. 3,751,268 disclose the coating of blanched potato pieces with an ungelatinized unmodified high amylose starch having an amylose content of at least 50 percent. The coated potato strips are deep fat fried during which the starch in the coating is gelatinized.

El-Hag et al. U.S. Pat. No. 4,317,842 discloses the process of dipping blanched potato strips in an aqueous ungelatinized starch slurry to coat the strips, which are next soaked in hot oil to gelatinize the starch in the coating. The strips are then parfried and frozen. The strips may be reheated for consumption by heating in an oven rather than by deep fat frying.

Lenchin et al., WO 85/01188 disclose batters comprising the flour of high amylose corn hybrids for producing microwaveable pre-fried foodstuffs. The use of flours of high amylose corn hybrids is said to provide pre-fried foodstuffs with improved crispness after microwave cooking which otherwise tends to make such products soggy.

Bell et al., U.S. Pat. No. 4,504,509 disclose batter compositions for potato strips comprising crosslinked high amylose corn starch (Hylon® VII, National Starch and Chemical Corp.) in combination with tapioca dextrin. Lenchin et al., U.S. Patent Nos. 4,595,597 and 4,529,607 and Zallie et al., U.S. Pat. No. 5,281,432 also disclose the use of high amylose corn starch or acetylated high amylose corn starch in french fry enrobing slurries. While high amylose corn starches can provide certain useful properties to french fry enrobing slurries their practical utility is limited by their expense.

Sloan et al., U.S. Pat. Nos. 5,059,435 and 5,141,759 disclose a process for preparing frozen coated potatoes wherein raw potatoes are washed, cut, blanched and partially dehydrated. The cut potatoes are then coated with an aqueous starch slurry comprising 15 to 35% by weight modified ungelatinized potato starch, 2 to 10% by weight modified ungelatinized corn starch, 2 to 10% by weight rice flour and other optional ingredients. The coated potato strips are parfried in oil and then frozen. The frozen strips are prepared for consumption by either finish frying in hot oil, or heating in an oven. The starch coating is said to enhance the holding quality of the ready to consume product and to improve the acceptability of the finished product by increasing the crispness of the outer surface, and helping to maintain the tenderness of the interior of the cut potato. In particular, the potato starch and corn starch are each said to contribute crispness to the coating, and because they are not gelatinized prior to the parfrying step they decrease clumping of the strips during processing. The rice flour is said to provide a desirable tenderness in the finished product.

The Sloan patents teach the use of potato starches which have been modified through known chemical cross-linking

processes in order to minimize sticking or clumping of the strips during processing, and coat the potato strips evenly. The Sloan patents disclose as preferred an ungelatinized chemically modified potato starch (K-1010, Penford Corporation, Richland, Wash.) which is crosslinked with phosphorus oxychloride ( $\text{POCl}_3$ ) at an effective level of 980 ppm. (This starch is characterized by a Brabender Amylograph viscosity of 50–100 BU ("Brabender units") when measured at a 9% starch solids concentration for 15 minutes at 95° C.) A chemically modified ungelatinized cornstarch said to be preferred for use in conjunction with the above modified potato starch is said to be Flojel® 60 (National Starch and Chemical Corp., Bridgewater, N.J.) which is said to contribute crispness to the coating and to produce an optimal result when present in the coating slurry at a concentration of between two and ten percent by weight.

Also of interest to the present application is the disclosure of Wu, et al. U.S. Pat. No. 5,648,110 which discloses use of potato starches with crosslinking levels which are generally higher than 550 ppm as preferred components of starch enrobing slurries. Further of interest is the disclosure of Woerman, et al. U.S. Pat. No. 5,750,168 which discloses preferred starch enrobing slurries containing crosslinked tapioca starches in combination with tapioca dextrins and high amylose corn starch.

References relating to use of starch hydrolysis products include Calder et al., U.S. Pat. No. 5,302,410 and Brusacker et al., U.S. Pat. No. 5,393,552 which teach the use of hydrolyzed starch products such as dextrins and maltodextrins as components of aqueous enrobing slurries. Specifically, the patents disclose contacting blanched potato strips with an aqueous solution which contains from 3% to 12% by weight of a hydrolyzed starch product characterized by a DE less than 12 and preferably from about 2 to 10. The patents specifically disclose the use of maltodextrins having a DE of 6 and teach against the use of maltodextrins having DE values greater than 12 because such hydrolyzate products build up reducing sugars and promote undesirable browning of the final product. The patents further teach that concentrations of the starch hydrolyzate products greater than 12% are undesirable because "at higher concentrations the surface of the potato strips become slightly tacky upon finish frying which promotes undesirable clumping of the potato strips."

Of further interest to the present invention is the disclosure (hereby incorporated by reference) of co-owned U.S. Pat. No. 5,897,898, which is directed to the finding that unexpected crispness can be obtained in a french fry coating composition by utilizing at least 40% by weight (on an as is solids basis) of a hydrolyzed starch characterized by a DE of from 0.2 to 0.8. This was particularly surprising in light of the teachings of Calder et al., U.S. Pat. No. 5,302,410; and Brusacker et al., U.S. Pat. No. 5,393,552 as discussed above.

Of further interest to the present invention is the disclosure of Melvej, U.S. Pat. No. 5,431,944 which discloses a dry batter mix for french fries comprising from about 1.5% to about 9% by weight of a leavening agent and from about 5% to about 40% by weight of a starch blend comprising a high amylose starch, a starch, from about 1% to about 8% by weight dextrin wherein the weight percent in the batter mix is inversely related to the weight percent of the leavening agent, and about 0.1% to about 2% of a food gum. The specification teaches that the batter mix preferably includes about 2% to about 6%, by weight of dextrin and that the dextrin "provides a tender bite and in improved mouthfeel to the reconstituted food product." The patent further teaches that "[t]he particular amount of dextrin included in the batter

mix is inversely related to the amount of leavening agent present in the batter mix. Therefore, as the amount of leavening agent in the batter is increased, the amount of dextrin in the batter mix is decreased, and vice versa. The dextrin mitigates the effects of the leavening agent and provides a more tender crispness. However, if too much dextrin is included in the batter mix, the reconstituted food product has a greasy mouthfeel." (Col. 7, lines 18-30).

Stubbs et al., U.S. Pat. No. 5,622,741 disclose starch enrobing slurries for potato products comprising the combination of corn flour, dextrins and dent corn starch wherein the dextrins are utilized as fillers. With its emphasis on corn flour the disclosure narrowly defines the modifications that may be made in the enrobing slurry ingredients.

Accordingly, there remains a desire in the art to provide further improvements in the use of dextrin containing enrobing slurries and further to provide improved properties of smoothness, crispness and extended hold time to enrobing slurries. Additionally, there remains a desire in the art to improve or maintain the properties of enrobing slurries while minimizing or eliminating the use of high amylose corn starch.

#### SUMMARY OF THE INVENTION

The present invention is directed to coating formulations which provide improved functionality to french fry (potato strip) products. As one aspect of the invention, it has been found that highly crosslinked dent (not high amylose) corn starch generally and acetylated crosslinked dent corn starch in particular provides improved functionality to french fry coating formulations and can be used to replace the presence of more expensive high amylose corn starch in a wide variety of french fry coating formulations. As a further aspect of the present invention it has been found that crosslinked corn starches generally and crosslinked acetylated corn starches specifically are particularly useful for enhancing the functionality of dextrins. In particular, the combination of acetylated crosslinked corn starches into a formulation comprising a first crosslinked starch (such as a potato starch) and a dextrin provides improved crispness to the french fry products coated with that formulation.

Specifically, the invention provides a starch enrobing slurry for coating the outer surface of a potato product and methods for preparing same the slurries having an as is solids content comprising: at least 30% by weight of a first crosslinked starch and at least 2% by weight of a crosslinked dent corn starch characterized by a crosslinking level of at least 500 ppm and a low soluble dextrin at from 5% to 20% by weight with a preferred dextrin as is solids content ranging from 8% to 16% by weight. The crosslinked dent corn starch is preferably present at a dry solids content of from 4% to 12% by weight and is preferably crosslinked at a level of greater than 900 ppm. Most preferably the crosslinked dent corn starch is acetylated. The first crosslinked starch may be selected from the group consisting of potato and tapioca starches but is preferably a crosslinked potato starch. According to a preferred aspect of the invention the crosslinked potato starch is characterized by a crosslinking level of less than 750 ppm and more preferably by a crosslinking level of from 200 ppm to 700 ppm with a crosslinking level of less than 550 ppm and from 300 ppm to 675 ppm being particularly preferred. When the crosslinked potato starch is characterized by a crosslinking level of less than 750 ppm the crosslinked corn starch is preferably characterized by a crosslinking level of equal to or greater than 900 ppm. The first crosslinked starch is more preferably present at a dry solids content of at least 48% by weight.

According to a further aspect of the invention, it has been found that highly crosslinked dent corn starches generally and highly crosslinked acetylated dent corn starches in particular can be used to substitute for the use of some or all of high amylose corn starches in french fry formulations. According to this aspect of the invention, it is believed that the high gelatinization temperature of the highly crosslinked dent corn starch and not the amylose content provides the critical improved functional characteristic of this ingredient.

Thus, the present invention further provides an aqueous starch enrobing slurry for coating the outer surface of a potato product having an as is solids content comprising: at least 30% by weight of a first crosslinked starch (which is preferably crosslinked potato or tapioca starch) and at least 2% (although preferably 4-12% by weight) by weight of a crosslinked dent corn starch characterized by a crosslinking level of at least 500 ppm with higher crosslinking levels being even more preferred. The crosslinked corn starches of the invention are preferably acetylated, characterized by a crosslinking level of greater than 900 ppm and are preferably present at a dry solids content of from 4% to 20% by weight. The crosslinked first starch is preferably crosslinked potato starch. The use of highly crosslinked dent corn starches allows improvements in french fry products comprising potato starches having lower crosslinking levels than would ordinarily provide optimum properties. Lower crosslinked potato starches are known to exhibit a rougher surface on the coated potato strip and pick up more frying oil. Thus, potato starches having crosslinking levels of less than 750 ppm to as low as 200 ppm provide improved coating properties when combined with the highly crosslinked dent corn starch. While the starches can be crosslinked according to any of a variety of methods known to the art, starches crosslinked with an agent selected from the group consisting of phosphorus oxychloride, sodium trimetaphosphate, adipic anhydride and epichlorohydrin are particularly preferred.

The invention further provides processes for preparing a frozen potato product with a film-like coating on the outer surface and the "french fry" products made thereby, which process comprises: cutting the raw potatoes; blanching the raw potatoes; partially drying the blanched potatoes; coating the partially dried potatoes with an aqueous starch slurries according to the invention; and freezing the coated potatoes. According to alternative embodiments such processes may be carried out which further comprise the step of par-frying the coated potatoes prior to freezing.

While the aqueous starch enrobing slurries of the invention may include a variety of additional ingredients particularly preferred slurries are characterized by an as is solids content comprising from 5% to 45% by weight and higher rice flour with rice flour concentrations ranging from 10% to 25% by weight rice flour being preferred.

The present invention provides improved aqueous starch enrobing slurries which provide improved flavor, crispness and other physical properties to coated potato products such as french fries. As one aspect of the present invention, starch enrobing slurries have been found that provide various improved properties to the resulting french fries which they are used to encoat.

#### DETAILED DESCRIPTION

Processes for the production of frozen french fries are well known and include the basic steps of preparing raw potatoes by washing, peeling and cutting into appropriately shaped pieces. The resulting potato strips are then blanched

according to conventional methods in order to inactivate enzymes in the potato and to leach sugars from the surface of the potato strip. According to one preferred method, the blanched potato strips are treated in a brine solution comprising components such as sodium chloride, dextrose and other ingredients known to the art. After these steps, the potato strips are then subjected to a drying step to reduce the moisture present in the strips.

The strips are then coated with the aqueous starch enrobing slurry of the invention. After blending of the solid ingredients with a desired amount of water to produce the french fry batter, the batter may be applied to coat the cut potato strips at a batter pickup of from about 8% to about 30% with a pickup of from 13% to about 18% being preferred and a coating pickup of about 15% being particularly preferred, (based on coated potato strips weight).

After coating with the coating composition, the potato strips are drained and parfried at a temperature of from about 360° F. to about 390° F. for a time period of from 40 seconds to about 90 seconds. Parfrying serves to gelatinize the starch of the potato strips and of the coating and removes moisture from the inside of the potato strip.

The potato strips are then frozen, packaged and preferably stored at a temperature below 0° F. until they are prepared for final consumption. In order to prepare the potato strips for consumption, they are cooked either by finish frying or by baking in an oven. After such preparation, potato strips prepared according to the invention are characterized by a crisp outer layer, a moist tender interior and improved flavor qualities compared to those prepared with coating compositions comprising corn starch components.

Minor amounts of modified pregelled potato starches may be used in the compositions of the invention to provide viscosity control and suspension of the solids in the batter. Specifically, preferred aqueous slurries may have an as is solids content of up to about 5% by weight of an unmodified pregelled potato starch for viscosity control. One preferred modified pregelled potato starch used as a viscosifier for such use is available commercially as PenPlus® 40 (213 ppm crosslinked) (Penford Food Ingredients Co., Englewood, Colo.) which can be incorporated into the batter composition at preferred solids concentrations of 1% to 5% by weight.

In addition, it has been found that the viscosity of the crosslinked starches may influence the overall qualities of the coated french fries. While the viscosities of crosslinked starches are generally controlled by the degree to which the starch is crosslinked it is believed that other factors, such as heat annealing may reduce viscosity and increase gelatinization temperatures and can affect the actual viscosity when used according to the invention and measured according to procedure set out below.

The modified starches used in practice of the invention are crosslinked with any of a variety of agents according to methods well known to the art but are preferably crosslinked with phosphorus oxychloride under alkaline conditions. As used herein crosslinking levels refer to levels of crosslinking using phosphorus oxychloride according to conventional methods and its equivalent using other crosslinking agents. Sodium trimetaphosphate is useful for crosslinking as is phosphorus oxychloride. Adipic anhydride is also useful as a crosslinking agent but reacts even more slowly than does sodium trimetaphosphate. Less preferably, epichlorohydrin may also be used at equivalent levels of crosslinking.

Different starches having different levels of crosslinking, and thus exhibiting different viscosities, may be used

together in practice of the invention. For example, one modified starch having a crosslinking level of 300 ppm and characterized by a relatively high viscosity may be used in conjunction with another modified starch having a crosslinking level of 1000 ppm and characterized by a relatively low viscosity to yield a blend of modified starches characterized by a crosslinking level and having a viscosity intermediate between those of the two components.

The method for determining the viscosity of crosslinked starches for use according to the invention utilizes a Brabender Amylograph viscometer according to conventional methods known to the art as set out below. Specifically, 45.0 grams of "dry basis" starch (to yield 13.5% solids) is placed in a beaker to which distilled water is added to make up 450 grams and is mixed thoroughly with a magnetic stirring bar. The pH of the mixture is adjusted to 7.0 with dilute (approximately 0.5%) NaOH or dilute (approx. 0.5%) HCl. The pH should be determined over a period of 5 to 10 minutes and should be measured both before and after the viscometer run. The starch slurry is then added to the viscometer bowl and the beaker rinsed with distilled water to give a total starch and water weight of 500 grams. The Brabender Amylograph is then run on program 2 comprising a starting temperature of 25° C., a heating rate of 1.5° C./minute to 95° C., running at 95° C. for 15 minutes wherein the measurement is taken at the conclusion of 15 minutes in Brabender units (BU), and cooling at 1.5° C./minute to 50° C. Those of skill in the art will recognize that operating the viscometer at alternative conditions will achieve differing results.

The starches of the invention may also be further modified by acetylation or hydroxypropylation but such modification is not necessary for practice of the invention. If the starches are so modified, it is generally necessary to increase the level of crosslinking in order to obtain an equivalent level of viscosity.

The starch enrobing slurries of the invention can optionally comprise a rice flour component at a solids concentration of from about 5% to about 45% (or even as high as 82% according to co-owned U.S. Pat. No. 6,022,569, the disclosure of which is incorporated by reference herein) by weight with concentrations of from about 10% to about 25% by weight (as is solids basis) being preferred. Rice flours suitable for use with the invention include long grain, medium grain or waxy rice with long grain rice flour being preferred. Long grain rice provides the best results for crispness, because of its higher amylose content in the starch. Use of medium grain rice flour tends to give a tough bite to the batter coating and waxy rice flour provides a hard crunch immediately after frying but the batter coating becomes soft and chewy within ten minutes after frying.

A variety of other flours and starches may optionally be used in producing the coating formulations of the invention including but not limited to potato starch, potato flour, wheat flour, wheat starch, oat flour, oat starch, corn flour and corn starch. Such starches may be crosslinked and/or substituted such as by acetylation or other means.

Optional minor ingredients for use in providing the coating compositions of the invention include maltodextrins, dextrins, microcrystalline cellulose, and hydrocolloids including hydroxypropyl methyl cellulose, and gums including xanthan gum, guar gum and the like which are used to provide improved structure and keeping qualities to the coated french fry products. Maltodextrins are preferably used at solids concentrations of up to 4%. Maltodextrins useful with the invention may be derived from any type of

starch including tapioca, potato and corn starch and include those characterized by having a DE in the range from 0.2 to 5 with maltodextrins having a DE of less than 2 being preferred as described in co-owned U.S. Pat. No. 5,897,898.

Dextrins obtained from a variety of sources, such as potato, corn and tapioca, may also be used according to the invention with potato dextrins being preferred. Suitable tapioca dextrins that may be used according to the invention include those commercially available as Crisp Coat® and Crisp Coat UC® (National Starch and Chemical Co.) which comprise tapioca dextrin alone or in combination with high amylose corn starch.

Preferred gum blends comprise approximately 10% gum by weight and are preferably incorporated into the compositions of the invention at solids concentrations of less than 0.1% gum by weight.

Leavening agents in the form of baking powders may also be incorporated into the compositions of the invention in order to open up the structure of the coating batters upon cooking and release moisture from the french fry products without blowing off the coating layer. Suitable baking powders include sodium bicarbonate plus one or more leavening acids such as those in the group consisting of sodium aluminum phosphate (SALP), sodium aluminum sulfate (SAS), sodium acid pyrophosphate (SAPP), dicalcium phosphate (DCP), and anhydrous monocalcium phosphate (AMCP). The combination of sodium bicarbonate and SAPP is preferred. Such leavening agents are preferably added at sodium bicarbonate concentrations of about 0.9 parts soda to 1.1 parts SAPP.

Additional ingredients include protein components such as sodium caseinate, nonfat dry milk, soy, whey, dried egg whites. Such proteins interact with the carbohydrates in the coating compositions to increase film strength, provide structure, improve crispness and prolong holding of crispness. Other ingredients include carbohydrate components such as methyl cellulose, hydroxypropyl methyl cellulose, microcrystalline cellulose and the like. Still other optional ingredients may also be incorporated into the coating formulations of the invention including salt, flavorings, seasonings and coloring agents such as whey or dextrose.

The french fry coating composition is prepared by dry blending of the various solid ingredients. Water is then slowly added to the dry ingredients in an amount selected to provide an appropriate viscosity to the coating batter. It has been found that aqueous slurries containing from about 150 parts to about 300 parts by weight water to 100 parts by weight of the solid ingredients are characterized by a preferred viscosity for coating of the potato strips. The ungelatinized starches do not substantially contribute to the viscosity of the solution.

The crispness of the batter coated french fries is determined by several factors including the cook-out of the starch, the moisture balance between the batter coating surface and inside of the fries, the thickness of the coating layer, and the interaction of ingredients in the coating formulation. These effects are best demonstrated on best quality potatoes. The coating forms a discontinuous film which lets the moisture from the inside of the fries escape or vent out, but will not absorb significant amounts of moisture into the coating layer. Controlling moisture migration is important to maintaining the crispness of the fries under a heat lamp. The coating should preferably be somewhat brittle, which gives a clean bite with minimum toughness. There is a fine balance between all the ingredients in the batter formula to achieve crispness and keeping quality with

the method used to process the potato strips contributing to the crispness of the french fries. It is further contemplated that the improved properties provided by the solids making up the starch enrobing slurries of the invention may also be provided when the solids ingredients making up the slurries are applied to potato products in a non-slurry form such as by dusting.

Other aspects and advantages of the present invention will be understood upon consideration of the following illustrative and comparative examples.

#### EXAMPLE 1

According to this example, acetylated and non-acetylated corn starches characterized by various levels of crosslinking were used to replace high amylose corn starch in a standard french fry coating formulation. In the formulation set out in Table 1-1 a 70% high amylose crosslinked corn starch (Hylon® VII, National Starch and Chemical) is used to promote crispness primarily with an added improvement in smoothness in the formulation. Table 1-2 shows the substitution of various other corn starches for the high amylose corn starch as the "test starch ingredient" in Table 1-1.

According to the method of this example, Russet-Burbank potatoes were peeled, cut into 1/32 inch strips and immersed and blanched in hot water for 6 minutes at 165° F. After blanching, the potato strips were immersed for 45 seconds in an aqueous solution comprising 2.4% salt and 0.2% SAPP based on total weight of water which was held at a temperature of 160°-170° F. After removal, the strips were drained and then dried in a conventional forced air oven dryer at 180° F. for a sufficient length of time (about 3 minutes) to effectuate a 12 to 14 percent water loss.

The components of Table 1-1 were dry blended and were hydrated at 40% solids by weight to produce a starch slurry and left to stand for at least 5 minutes before use. The potato strips were then dipped in the starch slurries. The potato strips were then drained for 60 seconds to remove excess slurry and to achieve a slurry coating pickup of 20% based upon original (as is) strip weight. The potato strips were then immediately parfried for 40 seconds at 360° F. The potato strips were then frozen and held overnight before being finished fried and evaluated for crispness and initial smoothness with the results are reported in Table 1-2 with the crispness results measured on a scale of 0-6.0 with 0 being least crisp and 6.0 being most crisp. Smoothness was evaluated on a scale of 0-6.0 with 0 being very rough and 6 being very smooth. The minimum acceptable score for crispness was about 4.0. The results as presented in Table 1-2 show that the products are characterized by high levels of crispness measured on a scale of 0-6.0 with 0 being least crisp and 6.0 being most crisp. The minimum acceptable score for crispness was about 3.0 to 3.5. The resulting products were then tested to evaluate their properties and the time period for which they maintained their crispness.

The results reported in Table 1-2 show that a low swelling starch (in this case the crosslinked dent corn having crosslinking levels greater than about 500 ppm, e.g. Exp. 1H-Exp 1N) may be used to replace high amylose corn starch in french fry coating formulations and in particular that the substitution of highly crosslinked acetylated dent corn starch for high amylose corn starch provides improved crispness and initial smoothness properties to the resulting french fries. Superior crispness is apparent for a 20 minute holding time along with obtaining a smooth finish to the final french fry product.

TABLE 1-1

Ingredients	%
XL potato starch (650 ppm) <sup>1</sup>	54.0
Rice flour - 80 Mesh	21.0
Xanthan gum	0.1
Salt	3.0
SAPP #4	1.0
Soda	0.8
SDE Maltodextrins	0.1
Potato Dextrin (15-20% soluble)	14.0
Test Starch Ingredient	6.0
	100.0

<sup>1</sup>Potato starch crosslinked using 650 ppm phosphorus oxychloride according to conventional methods (Penbind 170, Penford Food Ingredients Co.).

TABLE 1-2

Exp.	Test Starch	Crispness				Initial Smoothness
		5 min	10 min	15 min	20 min	
1A	High Amylose Corn (Hylon VII)	5.5	5.5	5.0	4.9	4/3
1B	Uncrosslinked Dent Corn	5.0	4.0	4.0	3.5	4
1C	Uncrosslinked Dent Corn	5.0	4.5	4.0	3.0	3.5/4
1D	XL (150 ppm) Dent Corn	5.5	5.0	4.0	3.5	4/3
1E	XL (150 ppm) Dent Corn	5.5	5.0	4.5	4.5	4
1F	XL (300 ppm) Dent Corn	5.5	5.0	4.5	3.5	4/3
1G	XL (300 ppm) Dent Corn	5.5	5.5	5.0	4.5	4
1H	XL (550 ppm) Dent Corn	5.5	5.5	5.5	5.5	5
1I	XL (550 ppm) Dent Corn	5.5	5.0	5.0	5.0	4.8
1J	XL (980 ppm) Dent Corn	5.5++	5.5++	5.5+	5.5+	6
1K	XL (980 ppm) Dent Corn	5.5+	5.5+	5.5	5.5	5
1L	Acetylated (4%) XL (980 ppm) Potato	5.5++	5.5++	5.5+	5.5+	6
1M	Acetylated (4%) XL (980 ppm) Potato	5.5+	5.5+	5.5+	5.5+	6
1N	Acetylated (4%) XL (980 ppm) Corn	5.5	5.5	5	4.5	4/3

## EXAMPLE 2

According to this example, the method of example 1 is repeated wherein potato strip coating formulations are prepared comprising the components of Table 2-1 wherein the test ingredient is present at higher concentrations. The test results reported in Table 2-2 confirm that the crosslinked dent corn having crosslinking levels greater than about 500 ppm may be used to replace high amylose corn starch in french fry coating formulations and in particular that the substitution of highly crosslinked acetylated dent corn starch for high amylose corn starch provides improved crispness and initial smoothness properties to the resulting french fries.

TABLE 2-1

Ingredients	%
XL potato starch (650 ppm)	54.0
Rice flour - 80 Mesh	21.0
Xanthan gum	0.1
Salt	3.0
SAPP #4	1.0
Soda	0.8
SDE Maltodextrins	0.1
Potato Dextrin (15-20% soluble)	9.0
Test Starch Ingredient	11.0
	100.0

TABLE 2-2

Exp.	Test Starch	Crispness				Initial Smoothness
		5 min	10 min	15 min	20 min	
2A	High Amylose (Hylon VII)	5.5	5.5	5.0	5.0	5
2B	Uncrosslinked Dent Corn	5.5	4.5	4.0	3.0	4
2C	XL (150 ppm) Dent Corn	5.5	5.0	4.5	4.5	4
2D	Acetylated (5%) XL (150 ppm) Dent Corn	5.5	5.0	4.5	4.0	4.8
2E	XL (300 ppm) Dent Corn	5.5	5.5	5.0	4.5	4
2F	XL (550 ppm) Dent Corn	5.5	5.5	5.0	5.0	4
2G	Acetylated (5%) XL (550 ppm) Dent Corn	5.5	5.5	5.5	5.5	6+
2H	XL (980 ppm) Dent Corn	5.5	5.5	5.5	5.5	5.5
2I	Acetylated (5%) XL (980 ppm) Dent Corn	5.5	5.5	5.5	5.5	6

## EXAMPLE 3

According to this example, crosslinked dent corn starch was used to enhance the properties of dextrins in french fry coating formulations. Specifically, enrobing slurries were prepared according to the method of example 1 using the formulations described in Table 3 below. French fries were then produced and evaluated as described above with the results reported in Table 3. These results show that crosslinked acetylated dent corn starch has the ability to enhance the crispness properties provided by dextrins. The results also show that highly crosslinked non-acetylated corn also has the ability to enhance the crispness properties of coated french fries. In addition, the results show that the combination of a low crosslinked (200 ppm) potato starch as a primary film forming starch with crosslinked corn starch as a secondary low gelling starch and a low solubility dextrin yields a smooth, crisp french fried potato product and that the use of the three components in combination provides improvements over the use of those ingredients individually and lowers the effective cross linking level required for the crosslinked potato starch as the primary starch.

TABLE 3

Ingredients	3A %	3B %	3C %	3D %	3E %	3F %	3G %	3H %
650 ppm XL potato	—	—	48	46	46	46	46	—
200 ppm XL potato	46.1	48	—	—	—	—	—	48
Xanthan gum	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Salt	5	5	5	5	5	5	5	5
SAPP #4	1.0	1.1	1.1	0.9	0.9	0.9	0.9	1.1
Soda	1.2	0.9	0.9	0.7	0.7	0.7	0.7	0.9
Rice flour - 30 mesh	25	24	24	24.5	24.5	24.5	24.5	24.5
Potato dextrin	15.5	—	—	11.9	11.9	11.9	21.5	—
Tapioca dextrin	—	12	12	—	—	—	—	20.8
990 ppm XL Acetylated (5%) Corn	6.0	8.8	—	10.8	—	—	—	—
980 ppm XL corn	—	—	—	—	10.8	—	—	—
300 ppm XL Corn	—	—	—	—	—	10.8	—	—
908 ppm XL Acetylated (4%) Potato	—	—	8.8	—	—	—	—	—
Evaluation								
Crispness								
5 min	5.5	5.5+	5.5	5.5	5.5	5.5	5.0	5.0
10 min	5.5	5.5+	5.0	5.5	5.5	4.5	5.0	5.0
15 min	5.0	5.5+	4.5	5.5	5.3	4.5	4.0	4.5
20 min	5.0	5.5+	4.5	5.5	5.3	4.2	4.0	4.5
Initial	4.5	5.5	4.5	5.5	5.5	5.5	4.5	4.5
Smoothness								

## EXAMPLE 4

According to this example, crosslinked dent corn starches characterized by different levels of acetylation were tested as the secondary low swelling starch in french fry enrobing slurries to determine the optimum level of acetylation. Specifically, french fry enrobing slurries were prepared according to the method of Example 1 using the formulation of Table 4-1. The resulting slurries were used to coat french fry products which were then evaluated according to that example. The results reported in Table 4-2 show that optimum acetylation levels for this particular experiment range from 2% to 4% with 3-4% providing the best results.

TABLE 4-1

Ingredients	%
XL (650 ppm) potato starch	48
XL (980 ppm) acetylated (x %) potato starch*	8.8
Xanthan gum	.2
Salt	5
SAPP 4	1.1
Soda	.9
Rice flour - 80 mesh	24
Tapioca dextrin	12

TABLE 4-2

Sample	Acetylation (%)	Crispness				Initial Smoothness
		5 min	10 min	15 min	20 min	
4A	1	5.5	4.5	4.0	3.8	4.5
4B	2	5.5	5.5	5.5	5.0	6
4C	3	5.5	5.5	5.5	5.5	6
4D	4	5.5	5.5	5.5	5.5	6
4E	5	5.5	5.0	4.5	4.5	5

## EXAMPLE 5

According to this example, a comparison was made between various french fry enrobing formulations comprising various substitutions of crosslinked (650 ppm) potato starch, highly crosslinked (980 ppm) dent corn starch and low soluble dextrin into a basic french fry formulation having as its primary components unmodified potato starch and rice flour. Specifically, french fry enrobing slurries were prepared according to the methods of Example 1 using the formulations of Table 5. The resulting slurries were used to coat french fry products which were then evaluated according to the methods of that example. The results reported in Table 5 show that the combination of crosslinked potato starch as a primary film forming starch with highly crosslinked dent corn starch as a secondary low swelling starch and potato dextrin as a low soluble dextrin provide significantly improved crispness and smoothness results over the use of those three components individually or in other combinations.

TABLE 5

Ingredients	5A %	5B %	5C %	5D %
650 ppm XL Potato Starch	46	—	—	—
Rice Flour 80 Mesh	24.5	24.5	24.5	24.5
Xanthan Gum	0.2	0.2	0.2	0.2
Salt	5	5	5	5
SAPP #4	0.9	0.9	0.9	0.9
Soda	0.7	0.7	0.7	0.7
980 ppm XL Corn Starch	10.8	10.8	10.8	—
Potato Dextrin	11.9	11.9	11.9	—
Potato Starch, Unmodified	—	46	56.8	68.7
Total Evaluation	100	100	100	100
Crispness				
5 min.	5.5	4.0	3.0	3.0
10 min.	5.5	3.0	3.0	3.0
15 min.	5.5	2.5	2.0	2.0
20 min.	5.5	2.5	1.5	1.0
Initial Smoothness	6.0	4.0	4.0	3.0

## EXAMPLE 6

According to this example, an evaluation was made of two french fry enrobing formulations not within the scope of the invention comprising either unmodified potato starch or unmodified dent corn starch as their primary film forming starch. Specifically, french fry enrobing slurries were prepared according to the methods of Example 1 using the formulations of Table 6. The resulting slurries were used to coat french fry products which were then evaluated according to the methods of that example. The results reported in Table 6 when compared to those of the preceding examples



## 13

show that the use of unmodified starches as the primary film forming starches without the presence of secondary low swelling starches such as highly crosslinked dent corn starch and low soluble dextrans provide poor properties to the resulting french fry products.

TABLE 6

Ingredients	6A %	6B %
Unmodified Potato Starch	70	—
Unmodified Corn Starch	—	70
Rice Flour	20.75	20.75
Xanthan Gum	0.5	0.5
PenPlus 40	1.20	1.20
Salt	5.0	5.0
SAPP #28	1.6	1.6
Soda	1.4	1.4
Total	100	100
Evaluation		
Crispness		
5 min.	5.0	4.0
10 min.	4.5	4.0
15 min.	3.0	3.0
20 min.	1.5	2.0
Initial Smoothness	3.0	3.0

Numerous modifications and variations in the practice of the invention are expected to occur to those skilled in the art upon consideration of the presently preferred embodiments thereof. Consequently, the only limitations which should be placed upon the scope of the invention are those which appear in the appended claims.

What is claimed is:

1. An aqueous starch enrobing slurry for coating the outer surface of a potato product having an as is solids content comprising:

at least 30% by weight of a first crosslinked starch, at least 2% by weight of a second crosslinked starch consisting of a crosslinked dent corn starch having a crosslinking level of at least 500 ppm and from 5% to 20% by weight dextrin.

2. The aqueous starch enrobing slurry of claim 1 wherein said crosslinked dent corn starch is acetylated.

3. The aqueous starch enrobing slurry of claim 2 wherein said acetylated corn starch has a crosslinking level of greater than 900 ppm.

4. The aqueous starch enrobing slurry of claim 1 wherein said first crosslinked starch is selected from the group consisting of potato and tapioca starches.

5. The aqueous starch enrobing slurry of claim 4 wherein said first crosslinked starch is a crosslinked potato starch.

6. The aqueous starch enrobing slurry of claim 5 wherein the crosslinked potato starch has a crosslinking level of less than 700 ppm.

7. The aqueous starch enrobing slurry of claim 6 wherein the crosslinked potato starch has a crosslinking level of less than 550 ppm.

## 14

8. The aqueous starch enrobing slurry of claim 7 wherein the crosslinked corn starch has a crosslinking level of greater than 900 ppm.

9. The aqueous starch enrobing slurry of claim 6 wherein the crosslinked potato starch has a crosslinking level of from 500 ppm to 675 ppm.

10. The aqueous starch enrobing slurry of claim 1 wherein said slurry comprises said first crosslinked starch at a dry solids content of at least 48% by weight.

11. The aqueous starch enrobing slurry of claim 1 wherein said slurry comprises dextrin at a dry solids content of from 8% to 16% by weight.

12. The aqueous starch enrobing slurry of claim 1 wherein said dextrin is potato dextrin.

13. The aqueous starch enrobing slurry of claim 1 wherein said slurry comprises crosslinked dent corn starch at a dry solids content of from 4% to 12% by weight.

14. An aqueous starch enrobing slurry for coating the outer surface of a potato product having an as is solids content comprising:

at least 30% by weight of a first crosslinked starch and at least 2% by weight of a second crosslinked starch consisting of a crosslinked dent corn starch having a crosslinking level of at least 500 ppm.

15. The aqueous starch enrobing slurry of claim 14 wherein said crosslinked dent corn starch has a crosslinking level of at least 900 ppm.

16. The aqueous starch enrobing slurry of claim 14 wherein said crosslinked dent corn starch is acetylated.

17. A process for preparing an aqueous starch enrobing slurry for coating the outer surface of a potato product which comprises:

forming an aqueous slurry having an as is solids content comprising at least 30% by weight of a first crosslinked starch, at least 2% by weight of a second crosslinked starch consisting of a crosslinked dent corn starch having a crosslinking level of at least 500 ppm and from 5% to 20% by weight dextrin.

18. The process of claim 17 wherein said dextrin is potato dextrin.

19. A process for preparing an aqueous starch enrobing slurry for coating the outer surface of a potato product which comprises:

forming an aqueous slurry having an as is solids content comprising at least 30% by weight of a first crosslinked starch and at least 2% by weight of a second crosslinked starch consisting of a crosslinked dent corn starch having a crosslinking level of at least 500 ppm.

\* \* \* \* \*

## EXHIBIT 8



US005928693A

**United States Patent** [19]  
**Friedman et al.**

[11] **Patent Number:** **5,928,693**  
[45] **Date of Patent:** **Jul. 27, 1999**

[54] **CLEAR COAT COMPOSITION FOR POTATO PRODUCTS AND METHOD OF MAKING**

[75] Inventors: **Robert Friedman**, Chicago, Ill.; **Eric Shinsato**, Highland, Ind.; **Robert Kerfin**, Minneapolis, Minn.

[73] Assignee: **Cerestar Holding B.V.**, Netherlands

[21] Appl. No.: **08/970,482**

[22] Filed: **Nov. 14, 1997**

[51] Int. Cl.<sup>6</sup> ..... **A23B 7/16; A23L 1/522; A23L 1/216**

[52] U.S. Cl. .... **426/102; 426/293; 426/549; 426/578; 426/637**

[58] Field of Search ..... **426/102, 293, 426/549, 578, 637**

[56] **References Cited**

**U.S. PATENT DOCUMENTS**

3,200,012 8/1965 Hay .  
3,527,606 9/1970 Taylor et al. .  
3,751,268 8/1973 Van Patten et al. .  
4,790,997 12/1988 Friedman et al. .

4,792,458 12/1988 Friedman et al. .  
5,035,912 7/1991 Furcsik et al. .  
5,120,562 6/1992 Furcsik et al. .  
5,141,759 8/1992 Sloan et al. .  
5,260,076 11/1993 Furcsik et al. .  
5,397,586 3/1995 Furcsik et al. .  
5,648,110 7/1997 Wu et al. .  
5,750,168 5/1998 Woerman et al. .

**FOREIGN PATENT DOCUMENTS**

94/21143 9/1994 WIPO .

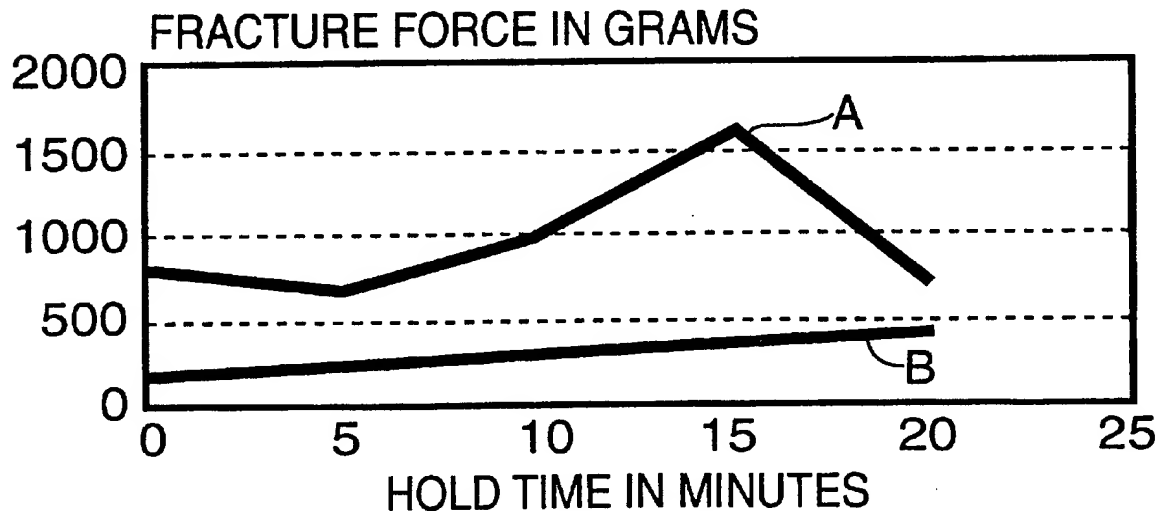
*Primary Examiner*—Helen Pratt

*Attorney, Agent, or Firm*—Bierman, Muserlian and Lucas

[57] **ABSTRACT**

The clear coat composition for french fries is a combination of an acetylated starch, a dextrin, and a rice flour. The acetylated starch has an acetyl content of 1.5% to 2.5% and is made from a starch obtained from a plant having a genotype selected from the group consisting of dull sugary-2 and amylose extender dull. The dextrin has a solubility of 10% to 20% and is made from a starch having an amylose content below 35%. The coating allows for an extended period of time under a heat lamp.

**20 Claims, 1 Drawing Sheet**



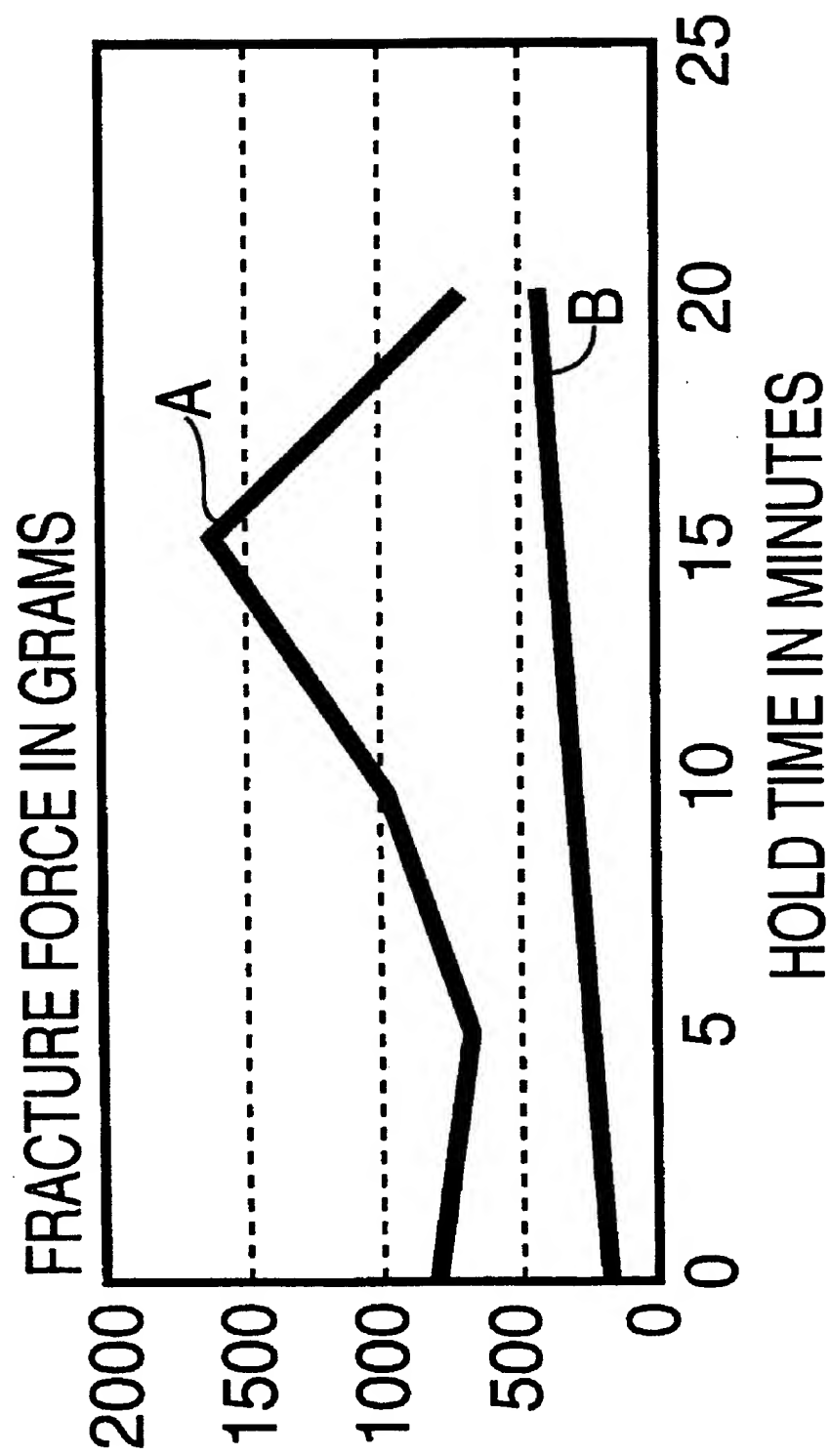


FIG. 1

## CLEAR COAT COMPOSITION FOR POTATO PRODUCTS AND METHOD OF MAKING

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

This invention relates to frozen, cut potato products, and, more specifically, a composition for clear coating cut potato products prior to freezing so as to prolong the life of the cut potato product once it has been fried and placed under a heat lamp.

#### 2. Prior Art

The food service industry conventionally employs frozen cut potatoes which are subsequently fried and served as french fries. Before consumption, the french fries are typically placed under a heat lamp to keep warm. Although crisp when removed from the fryer, the french fried potato loses its crispness when subjected to a heat lamp for a prolonged period of time. Additionally, both the texture and appearance of the french fried potato suffer due to exposure to the heat lamp.

In order to rectify this problem, cut potatoes are typically coated with a clear coat composition prior to freezing. The clear coat composition typically comprises water and a farinaceous component. The clear coat composition must not detract from the flavor or appearance after it has been fried. Examples of the farinaceous component used in clear coat compositions are taught in U.S. Pat. Nos. 3,751,268 (unmodified high amylose starch); 5,141,759 (a combination of chemically modified ungelatinized potato starch, chemically modified ungelatinized corn starch and rice flour); and in International Patent Application No. PCT/US94/02851 (a blend of wheat flour, modified corn or rice starch, corn or rice flour, a dextrin and a gum).

Oftentimes, these farinaceous components include a potato starch and a tapioca dextrin. Potato starch is often limited in commercial availability and usually commands a premium price. Tapioca starch is also often limited in supply and usually commands a premium price also. There is a need for a less expensive, more readily available clear coat composition for use on potato products which will protect the fried potato and allow the fried potato product to withstand the deleterious effects of a heat lamp.

### SUMMARY OF THE INVENTION

It has been found that certain acetylated starches in combination with a low solubility dextrin and a rice flour can be used in a clear coat for french fries to prevent the deleterious effects of the heat lamp. The acetylated starch, dextrin and rice flour form a farinaceous component which is used in the clear coat for the cut potato product. The acetylated starch is made from a starch which is obtained from a starch bearing plant having a genotype selected from the group consisting of dull sugary-2 (dusu2), and amylose extender dull (aedu).

When the cut potato product is prepared by conventional processing procedures and coated with the clear coat composition of the present invention, it has been found that the eating quality of the fried potato product in terms of crispness is improved, while the natural appearance of the potato product is retained. It has also been found that the fried potato product made in accordance with the present invention can be held under a heat lamp without significant loss of crispness or increase in toughness and toothpack.

Broadly, the farinaceous component of the present invention used for making a clear coat composition for a cut potato product prior to cooking comprises:

(a) about 55% to about 85% by weight of an acetylated starch having an acetyl content of about 1.5% to about 2.5%, wherein said starch is obtained from a starch bearing plant having a genotype selected from the group consisting of dull sugary-2, amylose extender dull;

(b) about 5% to about 25% by weight of a dextrin having a solubility of about 10% to about 20%, wherein said dextrin is made from a starch having an amylose content less than about 35% by weight; and

(c) about 5% to about 25% by weight of a rice flour.

Preferably, the farinaceous component comprises about 60% to about 80% by weight acetylated starch; about 5% to about 15% by weight dextrin; and about 10% to about 20% by weight rice flour.

More preferably, the farinaceous component comprises about 75% by weight acetylated starch; about 10% by weight dextrin; and about 15% by weight rice flour. The weight percents for the farinaceous component are based on the total weight of the three components in the composition, wherein their total weight adds up to 100%.

A clear coat composition made in accordance with the present invention comprises water and an effective amount of the farinaceous component of the present invention. Preferably, the clear coat composition comprises about 30% to about 45% by weight farinaceous component; and, more preferably, about 40% by weight farinaceous component, the remainder being water. These percents are based on the total weight of the clear coat composition.

The clear coat composition can also contain other ingredients such as seasoning or flavoring ingredients. Preferably, the clear coat composition contains no more than about 10% of these other ingredients. The preferred other ingredients are salt, sodium aluminum phosphate, and sodium bicarbonate.

In order to prepare the coated potato product, the cut potatoes are prepared in a conventional manner and then dipped into the clear coat composition of the present invention. In the case of frozen potato products, the cut potato product is coated with the clear coat composition prior to freezing.

### BRIEF DESCRIPTION OF THE INVENTION

FIG. 1 illustrates the crispness of a french fry made in accordance with the present invention to a conventional product.

### DETAILED DESCRIPTION OF THE INVENTION

Any plant source which produces edible starch and which can be bred to produce a plant having an aedu, or a dusu2 homozygous genotype may be used to obtain the starches which are used to make the acetylated starch in accordance with the present invention. It has been found that the amylose extender (ae) gene is present in maize and barley, and that cereal grains such as maize contain the dull (du), and sugary-2 (su2) genotypes. Maize (corn) is the preferred plant source for the starches used in the present invention.

The terms "amylose extender dull" or "aedu" genotype as used in the specification and claims mean not only the aedu homozygous genotype, aeaedudu, which has been obtained by standard plant breeding techniques, but also the aedu genotype which has been moved to another portion of the plant genome by translocation, inversion, or any other method of chromosome engineering to include variations thereof whereby the disclosed properties of the starch used in the present invention are obtained. The use of starches

from plants with the amylose extender dull genotype is taught in U.S. Pat. Nos. 5,497,586; 5,260,076; 5,120,562; 5,035,912; and 4,790,997. It is noted that the '562 patent teaches a batter mix containing acetylated aedu starch with a protein content of greater than or equal to 1%. The '562 patent does not teach the use of a dextrin or rice flour and the batter mix of the '562 patent does not work as well on french fries as the batter mix of the present invention.

The terms "dull sugary-2" or "dusu2" genotype as used in the specification and claims mean not only the dusu2 homozygous genotype, dudusu2su2, which has been obtained by standard plant breeding techniques, but also the dusu2 genotype which has been moved to another portion of the plant genome by translocation, inversion, or any other method of chromosome engineering to include variations thereof whereby the disclosed properties of the starch used in the present invention are obtained. The use of starches from plants with a genotype dull sugary-2 is disclosed in U.S. Pat. Nos. 4,792,458 and 5,260,076.

The terms "aedu starch" and "dusu2 starch" as used in the specification and claims mean starches obtained from starch-bearing plants which are of the aedu and dusu2 genotypes, respectively. The preferred starch for use in the present invention is dusu2 starch.

Acetylation of the starch granule is conducted in an aqueous medium in a conventional manner to obtain the appropriate acetyl content. Appropriate acetylating agents include vinyl acetate and acetic anhydride, the preferred acetylating agent is acetic anhydride. Suitable catalysts are sodium hydroxide, calcium hydroxide and sodium carbonate, calcium hydroxide is preferred.

The acetylated starch of the present invention has an acetyl content of about 1.5% to about 2.5% and, more preferably, about 2.5%. The acetyl content is measured as a percent by weight of acetyl groups based on the total weight of the acetylated starch. Acetyl content is determined in a conventional manner using The Standard Analytical Method C-2 Corn Refiners Association.

In order to acetylate the starch granules, a slurry of starch is prepared having about 5 to about 40% by weight starch and, more preferably, 30% to 35%. The pH of the slurry is then adjusted to about 8 to about 11. Preferably, the pH of the slurry is adjusted by the addition of calcium hydroxide, which is mixed thoroughly with the starch granules for about 30 minutes. Next, an acetylating agent is added to the slurry. The acetylating agent is added quickly while maintaining the pH of the slurry. The preferred acetylating agent, acetic anhydride, is added to the slurry in an amount to obtain the desired acetyl content. The reaction is continued for about 0.1 to about 1.0 hours at about 80° F. (25° C.) to about 120° F. (50° C.). Once the reaction is completed to the desired acetyl content, the pH slurry is adjusted to about 5 to about 6, diluted with water, dewatered, washed and dried.

The dextrin is made from a starch that has an amylose content of less than about 35% by weight and, more preferably, about 25-30% by weight. Suitable sources for the starch used to make the dextrin include potato, cassava (tapioca), rice, corn, wheat, sorghum and milo. The starch can be a waxy starch, a root starch, or a common cereal starch, provided the amylose content of the starch is below about 35%. The preferred plant source for the starch used to make the dextrin is maize and the preferred starch is common corn starch.

The dextrin used in the present invention is a pyrodextrin, i.e. one made by a process of pyroconversion. Historically, such dextrins were referred to as either British gums, white

dextrins, or yellow or canary dextrins, depending on their degree of conversion. In order to make a pyrodextrin in accordance with the present invention, a starch containing about 12.0% moisture by weight is sprayed with a dilute solution of an acid such as hydrochloric acid and heated to a temperature between about 200° F. (95° C.) and about 360° F. (185° C.) or more for a period of time that may range from two to ten and more hours to obtain the desired degree of degradation. The amount of acid and the temperature are determined by the desired product. As a practical matter, degradation of the starch is carried out to the extent that about 10% to about 20% by weight of the dextrinized starch is soluble in water. The acid customarily used is hydrochloric acid which is sprayed on the dry starch in an amount of up to about 0.04% by weight of starch. Higher amounts of hydrochloric acid may be used in a conventional manner. Besides hydrochloric acid, other suitable catalysts for use in converting the starch to a dextrin include nitric acid, monochloroacetic acid, phosphoric acid, and chlorine. Hydrochloric acid, however, is preferred. The amount of acid used is such to bring the pH of the starch to about 3.0. Other known conventional catalysts such as sodium bicarbonate, sodium phosphate or chlorine gas at a neutral or alkaline pH may be employed as a catalyst in the conversion step.

Any of the conventional roasting apparatus may be used such as the bulk cookers, fluidized bed dextrinizers or kiln type cookers. U.S. Pat. No. 3,200,012 describes one form of cylindrical drum roaster and U.S. Pat. No. 3,527,606 describes a paddle type roaster which may be conveniently employed for dextrinizing the starch. Roasting temperature may range from about 200° F. (95° C.) up to 350° F. (185° C.) and more depending on the type of roaster employed for a period of time of from about 2 up to about 10 hours to obtain a dextrin of desired solubility. The solubility of the dextrin of the present invention is about 10% to about 20% by weight; preferably about 10% to about 15% by weight and, more preferably, about 12% to about 15% by weight. Solubility is determined in a conventional manner by adding the dextrin to water at about 75° F. (24° C.) and stirring to form a slurry.

Any conventional rice flour can be used in the present invention. Suitable types of rice flour include RL100 sold by Rivland Partnership, Comet Rice Ingredients Company, and Pacific Grain Products Inc. RL100 is the preferred source of rice flour.

In order to prepare the clear coat composition in accordance with the present invention, the farinaceous component is mixed with water. Good results have been obtained by mixing the water into the farinaceous component but any conventional procedure can be employed.

In order to prepare a coated, frozen potato product in accordance with the present invention, raw potatoes are washed, peeled, cut into strips, blanched and dipped in a brine solution and then air dried. The potato strips are then coated with the clear coat composition of the present invention. Next, the coated potato strips are prefried for a short period of time (195° C. for 30 seconds) and then frozen.

To cook the frozen coated potato strips, they are removed from the freezer and cooked in a conventional manner, e.g. fried.

These and other aspects of the present invention may be more fully understood by reference to one or more of the following examples.

#### EXAMPLE 1

This example illustrates making an acetylated dusu2 starch in accordance with the present invention.

5

A slurry of a dusu2 starch is prepared at a solids content of 30%. Lime is added at 3.3% by weight dry starch. The starch is soaked for 30 minutes and then acetic anhydride in an amount of 8.8% based on weight of dry starch is added to the slurry while the slurry is under high agitation. The reaction is allowed to proceed for 15 minutes, at which time the pH is adjusted to about 5 to about 6. The slurry is then diluted with an equal amount of water, dewatered and dried. The resulting starch had an acetyl content of 2.5%.

#### EXAMPLE 2

This example illustrates making a dextrin in accordance with the present invention.

Common corn starch (28% amylose) was treated with gaseous hydrochloric acid to bring the pH of the starch to about 2.7 to about 2.8. The acidified starch was then slowly heated in a steam heated horizontal blender/reactor. Once the temperature of the starch reached 200° F. (95° C.) samples were taken to determine the solubility levels. Heating was continued until it reached 240° F. (215° C.) at which time the temperature was maintained. Once the solubility reached the range of 10% to 20%, the reaction was terminated by dropping the starch out of the reactor and into a cooler. Ammonium bicarbonate was added to the cooling starch to neutralize the acid and adjust the pH. The amount of bicarbonate added was about 0.03% by weight starch. The final solubility of the dextrin was 15%.

#### EXAMPLE 3

This example teaches making a clear coat composition, a coated, frozen potato product, and a french fry in accordance with the present invention using acetylated dusu2 starch.

The following dry composition was mixed together:

Ingredients	Percent
Acetylated dusu2 starch	68.0
Rice flour	15.0
Common corn dextrin	10.0
Salt (NaCl)	6.0
Sodium aluminum phosphate	0.5
Sodium bicarbonate	0.5
	100.0

The acetylated dusu2 was the one prepared in Example 1 while the dextrin was the one prepared in Example 2. The rice flour was Rivland's RL100 while the phosphate was Monsanto's Pan-O-Lite and bicarbonate was Church and Dwight's USP #1 grade.

The potatoes were washed, peeled and cut into 5/16 inch (0.8 cm) slices. Next, the potato slices were blanched at 170–180° F. (75–85° C.) for five minutes and then dipped into a solution of water and 0.05% sodium acid pyrophosphate. The potato slices were then dried in a convection oven at 200° F. (95° C.) for ten minutes.

The clear coat composition was prepared by dry blending the ingredients and then adding water to the dry blend in an amount of about 1.6 parts water to 1.0 parts dry mix by weight.

The potato slices were then dipped into the clear coat composition to obtain a pick up of about 14–16%. The coated potato slices were then prefried at 380° F. (195° C.) for 30 seconds and, finally, frozen at 0° F. (–20° C.).

The frozen product was fried at 350° F. (175° C.) for 2.5 minutes to produce a french fried potato. This initial product was taste tested by a taste panel.

6

The french fried potatoes were then placed under a heat lamp for 20 minutes and the heat lamp product was tested by the taste panel. The panel found no difference between the initial product and the heat lamp product.

#### EXAMPLE 4

This example teaches making a clear coat composition, a coated, frozen potato product, and a french fry in accordance with the present invention using acetylated aedu starch.

The following dry composition was mixed together:

Ingredients	Percent
Acetylated aedu starch	68.0
Rice flour	15.0
Common corn dextrin	10.0
Salt (NaCl)	6.0
Sodium aluminum phosphate	0.5
Sodium bicarbonate	0.5
	100.0

The acetylated aedu was prepared in the same manner as Example 1, except aedu starch was substituted for the dusu2 starch. The dextrin was the one prepared in Example 2. The rice flour was Rivland's RL100 while the phosphate was Monsanto's Pan-O-Lite and bicarbonate was Church and Dwight's USP #1 grade.

The potatoes were washed, peeled and cut into 5/16 inch (0.8 cm) slices. Next, the potato slices were blanched at 170–180° F. (75–85° C.) for five minutes and then dipped into a solution of water and 0.05% sodium acid pyrophosphate. The potato slices were then dried in a convection oven at 200° F. (95° C.) for ten minutes.

The clear coat composition was prepared by dry blending the ingredients and then adding water to the dry blend in an amount of about 1.6 parts water to 1.0 parts dry mix by weight.

The potato slices were then dipped into the clear coat composition to obtain a pick up of about 14–16%. The coated potato slices were then prefried at 380° F. (195° C.) for 30 seconds and, finally, frozen at 0° F. (–20° C.).

The frozen product was fried at 350° F. (175° C.) for 2.5 minutes to produce a french fried potato. This initial product was taste tested by a taste panel.

The french fried potatoes were then placed under a heat lamp for 20 minutes and the heat lamp product was tested by the taste panel. The panel found no difference between the initial product and the heat lamp product.

#### EXAMPLE 5

This example compares the clear coat composition of the present invention with a clear coat composition made with a conventional high amylose starch.

Two samples of frozen cut potato products were prepared in the same manner as taught in Example 3 above using the following two dry compositions to make up a clear coat composition which was used to coat the cut potato product.

Ingredients	Percents	
	Present Invention	Comparative
Acetylated dusu2 corn starch (2.5%)	68	—
Acetylated high amylose corn starch (2.50%)	—	68
Rice flour	15	15
Common corn dextrin	10	10
Salt (NaCl)	6.0	6.0
Sodium aluminum phosphate	0.5	0.5
Sodium bicarbonate	0.5	0.5

French fries were prepared from the frozen potato product in the same manner as taught in Example 3 above.

The fried product was then tested with a Stevens Texture Analyzer to determine the fracture force versus the hold time under a heat lamp. The data from these tests is illustrated in the graph in FIG. 1.

The coating graph in FIG. 1 illustrates that a french fry coated with the clear coat composition of the present invention marked Graph A required more force to break the clear coat on the french fry than a french fry coated with a clear coat composition containing a conventional acetylated high amylose starch marked Graph B. In other words, the present invention results in a higher level of crispness than a conventional product.

The Stevens Texture Analyzer was operated in a conventional manner using a flat nosed blade to test the strength of coating on the french fry. The blade employed was approximately 2 mm in width. The french fries were held under a conventional food service heat lamp which was spaced about 1 foot above the french fries. French fries were removed at five minute intervals starting at time 0 (when they were first placed under the heat lamp) and tested to determine the amount of force, in grams, necessary to cut through the coating of the french fry.

It will be understood that the claims are intended to cover all changes and modifications of the preferred embodiments of the invention herein chosen for the purpose of illustration which do not constitute a departure from the spirit and scope of the invention.

What is claimed is:

1. A farinaceous component for use in a clear coat composition for coating a potato product prior to cooking comprising:

- (a) about 55% to about 85% by weight of an acetylated starch having an acetyl content of about 1.5% to about 2.5% by weight, and made from a starch obtained from a plant having a genotype selected from the group consisting of dull sugary-2 and amylose extender dull;
- (b) about 5% to about 25% by weight dextrin having a solubility of about 10% to about 20%, and made from a starch having an amylose content less than about 35% by weight; and
- (c) about 5% to about 25% by weight of a rice flour.

2. The farinaceous component of claim 1 wherein said acetylated starch is present in an amount of about 60% to about 80% by weight, is made from a starch obtained from maize having a genotype of dull sugary-2, and has an acetyl content of about 2.5%.

3. The farinaceous component of claim 1 wherein said dextrin is present in an amount of about 5% to about 15% by weight, is made from a common corn starch, and has a degree of solubility of about 10% to about 15%.

4. The farinaceous component of claim 1 wherein said rice flour is present in an amount of about 10% to about 20% by weight.

5. The farinaceous component of claim 1 wherein

(a) said acetylated starch is present in an amount of about 75% by weight, is made from a starch obtained from maize having a genotype of dull sugary-2, and has an acetyl content of about 2.5%;

(b) said dextrin is present in an amount of about 10% by weight, is made from a common corn starch, and has a degree of solubility of about 12% to about 15%; and

(c) said rice flour is present in an amount of about 15% by weight.

6. A clear coat composition for coating a potato product prior to freezing comprising:

(a) water; and

(b) an effective amount of a farinaceous component comprising:

(b<sub>1</sub>) about 55% to about 85% by weight acetylated starch having an acetyl content of about 1.5% to about 2.5% by weight, and made from a starch obtained from a plant having a genotype selected from the group consisting of dull sugary-2 and amylose extender dull;

(b<sub>2</sub>) about 5% to about 25% by weight dextrin having a solubility of about 10% to about 20%, and made from a starch having an amylose content less than about 35% by weight; and

(b<sub>3</sub>) about 5% to about 25% by weight of a rice flour.

7. The clear coat composition of claim 6 wherein said acetylated high amylose starch is present in the farinaceous component in an amount of about 75%, is made from a starch obtained from maize that has a genotype of dull sugary-2 and has an acetyl content of about 2.5%.

8. The clear coat composition of claim 7 wherein said dextrin is present in said farinaceous component in an amount of about 10%, is made from a common corn starch, and has a degree of solubility of about 12% to about 15%; and said rice flour is present in said farinaceous component in an amount of about 15%.

9. The clear coat composition of claim 6 further comprising seasonings and preservatives.

10. The clear coat composition of claim 6 wherein the amount of said farinaceous component present in said clear coat composition is about 40% by weight of said clear coat composition.

11. A frozen potato product which has been coated with a clear coat composition prior to freezing wherein said clear coat composition contains as an essential ingredient therein a farinaceous component comprising:

(a) about 55% to about 85% by weight of an acetylated starch having an acetyl content of about 1.5% to about 2.5% by weight and made from a starch obtained from a plant having a genotype selected from the group consisting of dull sugary-2 and amylose extender dull;

(b) about 5% to about 25% by weight dextrin having a solubility of about 10% to about 20% and made from a starch having an amylose content less than about 35% by weight; and

(c) about 5% to about 25% by weight rice flour.

12. The frozen potato product of claim 11 wherein said acetylated starch is present in said farinaceous component in an amount of about 75% by weight, is made from a starch obtained from maize that has a genotype of dull sugary-2 having an acetyl content of 2.5%.

13. The frozen potato product of claim 12 wherein said dextrin is present in said farinaceous component in an



9

amount of about 10%, is made from a common corn starch, and has a degree of solubility of about 12% to about 15%; and said rice flour is present in said farinaceous component in an amount of about 15%.

14. The frozen potato product of claim 11 wherein said clear coat composition further comprises seasoning or flavoring ingredients.

15. The frozen potato product of claim 14 wherein said seasoning or flavoring ingredients comprise salt, sodium aluminum phosphate, and sodium bicarbonate.

16. A method for making a clear coat composition for coating a potato product prior to freezing comprising:

(a) forming a farinaceous component comprising:

(a1) about 55% to about 85% by weight of an acetylated starch having an acetyl content of about 1.5% to about 2.5% by weight, and made from a starch obtained from a plant having a genotype selected from the group consisting of dull sugary-2 and amylose extender dull;

(a2) about 5% to about 25% by weight dextrin having a solubility of about 10% to about 20%, and made from a starch having an amylose content less than about 35% by weight;

(a3) about 5% to about 25% by weight of a rice flour; and

(b) mixing water with an effective amount of said farinaceous component to form a clear coat composition for coating a potato product.

10

17. The method of claim 16 wherein the amount of said farinaceous component is about 30 to 45% by weight of said clear coat composition.

18. A method for preparing a frozen potato product comprising:

(a) coating a potato product with a clear coat composition comprising:

(a1) about 55% to about 85% by weight of an acetylated starch having an acetyl content of about 1.5% to about 2.5% by weight, and made from a starch obtained from a plant having a genotype selected from the group consisting of dull sugary-2 and amylose extender dull;

(a2) about 5% to about 25% by weight dextrin having a solubility of about 10% to about 20%, and made from a starch having an amylose content less than about 35% by weight;

(a3) about 5% to about 25% by weight of a rice flour; and

(b) freezing said coated potato product.

19. The method of claim 18 wherein after coating but before freezing, said coated potato product is prefried for about 30 seconds.

20. The method of claim 19 wherein said coating is accomplished by dipping said potato product into said clear coat composition.

\* \* \* \* \*

## EXHIBIT 9

Food Products Division  
10 FINDERNE AVENUE  
P.O. BOX 6500  
BRIDGEWATER, NEW JERSEY 08807-0500  
908-685-5000

## TECHNICAL SERVICE BULLETIN

# CRISPCOAT™ PRODUCTS

## Crispcoat UC, National® 0280 and National® 814

The CRISPCOAT products are starch based crisping agents designed to impart a range of textural properties to battered and fried food products, particularly french fries. CRISPCOAT UC is a specialty blend of high amylose corn starch and tapioca dextrin; NATIONAL 0280 is a tapioca dextrin, and NATIONAL 814 is a modified food starch derived from corn.

### Physical Properties:

	<u>CRISPCOAT UC</u>
Color	Off-white
Form	Powder
Moisture	Approximately 11%
pH	Approximately 5

	<u>NATIONAL 0280</u>
Color	Off-white
Form	Powder
Moisture	Approximately 7%
pH	Approximately 5

	<u>NATIONAL 814</u>
Color	Off-white
Form	Powder
Moisture	Approximately 11%
pH	Approximately 5

### Features and Benefits:

The CRISPCOAT products when incorporated into a batter at low levels impart unique textural properties to fried applications. NATIONAL 0280 yields a very crispy coating which is characterized by a slightly blistered appearance. CRISPCOAT UC imparts a smooth uniform appearance to the fried product and provides a slightly firmer crispiness.

Batters containing NATIONAL 814 have moderate uniformity of coating and crisping.

In addition to the textural enhancement provided by these starches to coated products, they also assist with maintaining a crispy texture during extended storage under heat lamps. Typically, products formulated with the CRISPCOAT series may yield up to 30 minutes or more of crispiness under heat lamp storage.

### Applications:

The CRISPCOAT products can be used in batters for the coating of varied fried products. Batters typically contain one or more CRISPCOAT products in combination with a flour (wheat or corn) and seasoning/spices. CRISPCOAT will enhance the texture, crispness, and overall appearance of coated and fried products. These starches impart excellent crispness to various sizes and cuts of potato products.

When preparing batters made with CRISPCOAT, it is important to keep the batter agitated at all times to prevent settling of solids.

National also offers other specialty starches which can be used in combination with the CRISPCOAT series to impart desirable properties such as adhesion, color enhancement, or other textural properties.

### Label Declaration:

CRISPCOAT UC:	High amylose corn starch and dextrin
NATIONAL 0280:	Tapioca dextrin
NATIONAL 814:	"Food Starch-Modified"

MFB011

The information given and the recommendations made herein are based on our research and are believed to be accurate, but no guaranty of their accuracy is made. In every case we urge and recommend that purchasers before using any product in full scale production make their own tests to determine to their own satisfaction whether the product is of acceptable quality and is suitable for their particular purposes under their own operating conditions. THE PRODUCTS DISCLOSED HEREIN ARE SOLD WITHOUT ANY WARRANTY AS TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED. No representative of ours has any authority to waive or change the foregoing provisions but, subject to such provisions, our engineers are available to assist purchasers in adapting our products to their needs and in the circumstances prevailing in their business. Nothing contained herein shall be construed to imply the non-existence of any relevant patents or to constitute a permission, inducement or recommendation to practice any invention covered by any patent, without authority from the owner of said patent. We also expect purchasers to use our products in accordance with the guiding principles of the Chemical Manufacturers Association's Responsible Care® program.

## EXHIBIT 10

# Specialty-Corn Types

## Waxy Corn

Waxy corn has carved out a formidable position as a raw material for the production of amylopectin starch which is processed by certain wet millers in the USA, Canada, Europe, and other countries for industrial and food uses. Waxy corn is easy to identify. Since waxy is a single recessive gene, production fields must be isolated from normal dent corn. A majority of the commercially produced waxy grain is produced under contract to wet milling companies.

## High Amylose (Amylomaize) Corn

Amylomaize is the generic name for corn that has an amylose content of around 50% or greater. The single recessive *amylose-extender* gene, plus modifiers, gives a range in amylose content of 50 to 94%. Amylomaize hybrids require special management and cultural requirements to provide more assurance of optimum grain production of acceptable quality and purity. Production fields must be isolated from normal dent corn. High-amylose grain is grown exclusively under contract for wet milling. Amylose starch is utilized in a complexity of uses in various industries. The two major types of high-amylose grain are Class V (amylose percentages in the 50% range) and Class VII (amylose content from 70 to 80%). Class VIII amylomaize (80-90%) and Class IX (>90%) can be produced but presently they are not commercialized.

## Other Specialty Starch Corn

There are a number of genetically modified specialty corn varieties that offer several characteristics and produce value-added properties to the grain. These specialty corn strains possess unique structural and functional properties for utilization by the corn processing industry for the production of specialty starches. Specialty starches may be used in various industrial applications and food systems, for example in enhancing food products where these genetically diverse starches offer new and different functionalities and bases for chemical modifications that are currently not available. Examples of specialty corn varieties producing enhanced amylose starches with unique characteristics are: (1) *amylose-extender dull*, (2) *amylose-extender waxy*, (3) *amylose-extender sugary-2* and (4) *dull sugary-2*. Examples of specialty corn varieties producing amylopectin-rich starches are: (1) *dull waxy*, (2) *dull soft-starch*, (3) *waxyfloury* and (4) *waxy shrunk-1*. The specialty corn products mentioned are approaching commercial distribution in the foreseeable future, although currently there are limited commercial quantities of some of these varieties grown.

---

Submitted by David V. Glover, Department of Agronomy, Purdue University

---

## EXHIBIT 11



US005260076A

**United States Patent** [19]

Furcsik et al.

[11] **Patent Number:** **5,260,076**[45] **Date of Patent:** **Nov. 9, 1993**[54] **PIZZA CRUST**[75] **Inventors:** Susan Furcsik, Lake Station; Carol Stankus, Whiting, both of Ind.[73] **Assignee:** American Maize-Products Company, Stamford, Conn.[21] **Appl. No.:** 11,277[22] **Filed:** Jan. 29, 1993[51] **Int. Cl.<sup>5</sup>** ..... A21D 2/36[52] **U.S. Cl.** ..... 426/21; 426/549[58] **Field of Search** ..... 426/21, 549[56] **References Cited****U.S. PATENT DOCUMENTS**4,774,328 9/1988 Friedman et al. .... 426/578 X  
4,789,557 12/1988 Friedman et al. .... 426/589 X4,789,758 12/1988 Friedman et al. .... 426/578 X  
4,790,997 12/1988 Friedman et al. .... 426/578  
4,792,458 12/1988 Friedman et al. .... 426/578*Primary Examiner*—Joseph Golian  
*Attorney, Agent, or Firm*—Lucas & Just

## [57]

**ABSTRACT**

The improved pizza crust is made by incorporating an effective amount of a novel starch obtained from a plant having a genotype selected from the group consisting of amylose extender dull, dull horny, dull sugary-2, and dull waxy. The amount of novel starch added to the dough is 1 to 15 parts by weight based on parts by weight flour. Improved freezer resistance is provided to the crust by incorporating the novel starch.

**13 Claims, No Drawings**

## PIZZA CRUST

This invention relates to pizza crust and, more particularly, to a dough formulation which provides good freezer resistance to the crust made from the dough.

Pizza is an open pie made by forming an open pie shell into which is spread a spiced mixture, e.g. tomato sauce, cheese and meat. Typically, the dough comprises flour, water and yeast. Pizza is often prepared by industrial food manufacturers and then frozen for sale to consumers. In order to consume the frozen pie, the consumer merely heats the pie in an oven. There is a need for the pizza crust to have good freezer resistance. Freezer resistance means the ability of the crust to withstand both the egress and ingress of moisture while the pie is in a frozen state. This movement of moisture can cause the crust to either become soggy due to the ingress of water or hard and dry due to the egress of water.

It has now been discovered that by using an effective amount of a novel starch obtained from a plant having a genotype selected from the group consisting of amylose extender dull, dull horny, dull sugary-2 and dull waxy in the dough that the resulting pizza crust has improved freezer resistance. More specifically, in order to improve the freezer resistance of a pizza crust, the pizza crust is made from a dough which comprises water, flour, yeast and an effective amount of one or more of said novel starches.

The amount of novel starch used in the dough formulation is effective to improve the freezer resistance of the crust. More preferably, the amount of novel starch used in the dough is about 1 part to about 15 parts by weight based on 100 parts by weight of flour. Even more preferred, the amount of novel starch used in the dough is about 2 parts to about 10 parts by weight per 100 parts by weight of flour; and most preferred, the amount of novel starch added to the dough is about 5 parts by weight based on 100 parts by weight flour.

The proportions of the other components used in the present invention are maintained in accordance with conventional formulations or slightly adjusted due to the addition of the novel starches as taught herein.

Additional water is preferably added to the dough when the novel starch is in granular form. The amount of additional water added depends on the workability of the dough and one of skill in the art can determine the amount of additional water needed for the dough. Preferably, the amount of additional water added to the dough is about 20 parts to about 80 parts by weight based on 100 parts by weight novel starch. More preferably, the amount of additional water added to the dough is about 25 parts to about 75 parts by weight based on 100 parts of novel starch.

All purpose wheat flour has been found to work well in the present invention; however, any flour along with mixtures of different flours such as wheat, rye, corn, rice, etc. may be used.

The term "starch" as used in the specification and claims means not only the substantially pure starch granules as extracted from a starch-bearing plant but also grain products of the starch granule such as flour, grit, hominy, and meal, so long as these starches have not been chemically modified or treated to substantially alter the makeup of the anhydroglucose monomeric units or the polymeric structure of the starch. Preferably, the starch used in the present invention is in the

granular form, without any physical or chemical modification.

The terms "amylose extender dull" or "aedu" genotype as used in the specification and claims mean not only the aedu homozygous genotype, aeaedudu, which has been obtained by standard plant breeding techniques, but also the aedu genotype which has been moved to another portion of the plant genome by translocation, inversion, or any other method of chromosome engineering to include variations thereof whereby the disclosed properties of the starch used in the present invention are obtained.

The terms "dull horny" or "duh" genotype as used in the specification and claims mean not only the duh homozygous genotype, duduhh, which has been obtained by standard plant breeding techniques, but also the duh genotype which has been moved to another portion of the plant genome by translocation, inversion, or any other method of chromosome engineering to include variations thereof whereby the disclosed properties of the starch used in the present invention are obtained.

The terms "dull sugary-2" or "dusu2" genotype as used in the specification and claims mean not only the dusu2 homozygous genotype, dudusu2su2, which has been obtained by standard plant breeding techniques, but also the dusu2 genotype which has been moved to another portion of the plant genome by translocation, inversion, or any other method of chromosome engineering to include variations thereof whereby the disclosed properties of the starch used in the present invention are obtained.

The term "dull waxy" or "duwx" genotype as used in the specification and claims means not only the duwx homozygous genotype, duduwwxw, which has been obtained by standard plant breeding techniques, but also the duwx genotype which has been moved to another portion of the plant genome by translocation, inversion, or other methods of chromosome engineering to include variations thereof whereby the disclosed properties of the starch used in the present invention are obtained.

The terms "aedu starch", "duh starch", "dusu2 starch", and "duwx starch" as used in the specification and claims mean starches obtained respectively from starch-bearing plants which are of the aedu, duh, dusu2, and duwx genotypes.

U.S. Pat. Nos. 4,774,328 issued Sep. 27, 1988; 4,790,997 issued Dec. 13, 1988; 4,789,557 issued Dec. 6, 1988; and U.S. Pat. No. 4,792,458 issued Dec. 20, 1988 disclose, respectively, the duh, aedu, duwx, and dusu2 starches and their use in foodstuffs. These patents are incorporated herein by reference.

Any plant source which produces edible starch and which can be crossbred to produce a plant having an aedu, a duh, a dusu2 or a duwx genotype may be used to obtain the starches which are used in accordance with the present invention. It has been found that the amylose extender (ae) gene is present in maize and barley, and that cereal grains such as maize contain the dull (du), horny (h), sugary-2 (su2), and waxy (wx) genotypes. Maize is the preferred plant source for the starches used in the present invention.

In order to make a pizza crust in accordance with the present invention, all of the dry components are first mixed together, e.g. flour, novel starch, sugar, and salt. Yeast is mixed into warm water and added along with the water subsequent to the addition of the shortening.



A conventional method with conventional equipment is employed to make the pizza dough and bake the pizza crust.

Although it is proposed that the use of the novel starches in accordance with the present invention is in a pizza which is premade, frozen and sold in stores to consumers for reheating and consumption, the novel starches of the present invention can also be used in frozen pizza dough which is sold to consumers or restaurants.

These and other aspects of the present invention may be more fully understood by reference to the following examples.

### EXAMPLE 1

The following illustrates the use of an aedu starch in a pizza crust formulation. The following ingredients were used to make the pizza dough:

Ingredient	Amount (grams)
Flour, all purpose	1525.25
Water 80° F. (27° C.)	896.00
Yeast, dry active	20.50
Sugar	9.50
Salt	23.75
Shortening	25.00
Novel starch, aedu granular	72.26
Additional water	37.41

The dough and crust were prepared by combining 100 grams of 80° F. (27° C.) water with the dry active yeast and then allowing this slurry to sit for 20 minutes while the remaining ingredients were mixed. First the dry ingredients of flour, aedu starch, and sugar were mixed and then the shortening was mixed into the dry ingredients. To this mix the remaining water, along with the yeast slurry and additional water was added. The dough was then put aside and allowed to rise to double its size. After rising, the dough was cut and formed into flat open pie shells. About 280 grams of dough was used for each crust. The open pie shells were then cooked in a convection oven at 425° F. (220° C.) for about 15 to 20 minutes until the crust was golden brown. The cooked crust was then removed from the oven, allowed to cool and 120 grams of pizza sauce was placed on the top of the cooled crust. The following formulation was used for the pizza sauce:

Ingredients	Amount (% by weight)
Tomato puree	55.19
Water	37.04
Sugar	4.27
Starch (modified duwx starch)	1.46
Salt	0.95
Fresh whole oregano	0.23
Fresh whole basil	0.16
Garlic powder	0.15
Fresh whole thyme	0.10
Toasted dried chopped onion	0.14
Black pepper	0.09
Parmesan/Romano cheese flavor	0.22

The sauce was made by combining all the ingredients and cooking them for a short period of time in a jacketed kettle. On the top of the sauce-covered crust, 120 grams of shredded low fat, Italian cheese blend was added. The finished pie was then frozen (0° C.).

To provide a comparison, a conventional pizza pie formulation was made using the dough and sauce for-

mulation above except no novel starch or additional water was added to the dough.

A taste panel of seven persons tested both crusts, conventional and present invention, after one day of frozen storage. In order to reheat the frozen pies, they were placed in a convection oven for 12 minutes at 400° F. (205° C.). The taste panel found that the control pie had a wet layer directly under the sauce and that the bottom crust of the control was hard, dry and crunchy. The pie made in accordance with the present invention had no wet layer and was only slightly dry. Overall, the taste panel found the pie crust made in accordance with the present invention was better than the control pie.

After 32 days of frozen storage, a taste panel of eight was assembled and the frozen pies reheated in the same manner as before, 12 minutes at 400° F. (205° C.). This time the panel found the crust of the control pie to be very doughy and wet under the sauce. The crust of the control was found to be chewy and tough by the taste panel. In contrast, the crust made in accordance with the present invention was not as soggy or doughy as the control pie and was not as tough as the control pie.

Overall, the crust of the present invention was found to be superior to the control. The panel found that the crust made in accordance with the present invention was somewhat bread-like in consistency with a crispy bottom crust.

### EXAMPLE 2

This example illustrates using a duh starch in a pizza crust formulation.

A pizza pie was made in accordance with Example 1 and frozen; however, the amount of additional water used in the dough was 44.98 grams and 72.26 grams of a granular duh starch was employed rather than aedu starch.

After one day of frozen storage, the pie was heated as in Example 1, 12 minutes at 400° F. (205° C.), and evaluated by a taste panel of seven people along with the control. The panel found that the pie using duh starch was bread-like in appearance, i.e. more volume, and that the bottom of the crust was crunchy. The panel found that the crust was not as soggy as the control pie.

After 32 days of frozen storage, the pie was heated, as above, and the taste panel of eight tested the pie along with the control. It was found that the crust using duh starch was less soggy than the control, and had a bread-like consistency.

Overall, the taste panel found crust made with duh starch to be superior to the control crust.

### EXAMPLE 3

This example illustrates using a dusu2 starch in a pizza crust formulation.

A pizza pie was made in accordance with Example 1 and frozen; however, the amount of additional water used in the dough was 39.33 grams and 72.26 grams of a granular dusu2 starch was used instead of aedu starch.

After one day of frozen storage, the pie was heated as in Example 1, 12 minutes at 400° F. (205° C.), and evaluated by the taste panel of seven people along with the control. The panel found that the pie using dusu2 starch was bread-like in appearance, i.e. more volume, and the top of the crust, next to the sauce, was wet.

After 32 days of frozen storage, the pie was heated, as above, and the taste panel of eight tested it along with the control. It was found that the crust using dusu2

starch was less soggy than the control, and had a bread-like consistency.

Overall, the taste panel found the crust made with dusu2 starch to be superior to the control crust.

#### EXAMPLE 4

This example illustrates using a duwx starch in a pizza crust formulation.

A pizza pie was made in accordance with Example 1 and frozen; however, the amount of additional water used in the dough was 53.83 grams and 72.26 grams of a granular duwx starch was used instead of aedu starch.

After one day of frozen storage, the pie was heated as in Example 1, 12 minutes at 400° F. (205° C.), and evaluated by the taste panel of seven people against the control pie. The panel found that the pie using duwx starch was bread-like in appearance, i.e. more volume, and that the bottom of the crust was crunchy. The panel found that the crust was not as soggy as the control crust.

After 32 days of frozen storage, the pie was heated, as above, and the taste panel of eight tested it against the control. It was found that the crust using duwx starch was not soggy like the control, had a bread-like consistency, and the bottom crust was crunchy.

Overall, the crust made with duwx starch was found to be superior to the control crust and was rated the best of all the crusts tested herein.

#### EXAMPLE 5

This example illustrates heating a frozen pizza having a dough made in accordance with the present invention in a microwave oven.

Three pizza doughs were prepared in accordance with the present invention; a dough containing aedu starch and made in accordance with Example 1; a dough containing duh starch and made in accordance with Example 2; a dough containing duwx starch and made in accordance with Example 4. For comparative purposes, two other conventional doughs were prepared; a control dough containing only flour and made in accordance with Example 1; and a dough containing 72.26 grams of a conventional high amylose starch instead of the novel starch of the present invention, and 37.41 grams of additional water. In order to make the dough with conventional high amylose starch, the procedure of Example 1 was used except conventional high amylose starch was used in place of the aedu starch. The conventional high amylose starch was AMAIZO 5 which was commercially available from American Maize-Products Company.

For each of these dough formulations, 36.5 grams of dough was used to make a pizza crust in accordance with Example 1. To these crusts 17.0 grams of pizza sauce made in accordance with Example 1 and 36.5 grams of shredded low fat, Italian cheese blend were added. These five pizzas were then frozen in accordance with Example 1 and removed from frozen storage after seven days.

In order to reheat the frozen pizzas in a microwave oven, a susceptor was used and the microwave oven was set on high (750 watts). The pizzas were then individually heated for approximately 1.5 minutes in the microwave oven.

A taste panel of four panelists then evaluated each of the pizzas. Focusing on the pizza crust itself, the overall comments from the panel were as follows:

Control Dough had a tough texture, it was wet, breadly and stale.

duwx: Crust was tougher than duh but not as tough as the control. The crust was breadly with a hard bottom.

aedu: The crust was like a cracker crust on the bottom. It was not as crunchy as the crust made with AMAIZO 5. The crust was doughy and semi-bready.

duh: The crust had good texture and overall this sample was the best of the five crusts.

AMAIZO 5: The crust was tight, crunchy and hard. The texture of the crust was not wet; rather, it was a cracker-type crust.

It will be understood that the claims are intended to cover all changes and modifications of the preferred embodiments of the invention herein chosen for the purpose of illustration which do not constitute a departure from the spirit and scope of the invention.

What is claimed is:

1. An improved pizza crust made from a dough comprising flour, yeast and water wherein the improvement comprises adding an effective amount of a novel starch obtained from a plant having a genotype selected from the group consisting of amylose extender dull, dull horny, dull sugary-2 and dull waxy, the amount being effective to improve the freezer resistance of the dough.

2. The crust of claim 1 wherein said novel starch is obtained from maize.

3. The crust of claim 1 wherein said novel starch is in granular form.

4. The crust of claim 1 wherein said novel starch is present in said dough in an amount of about 1 part to about 15 parts by weight based on 100 parts by weight flour.

5. The crust of claim 1 wherein said novel starch is present in said dough in an amount of about 2 parts to about 10 parts by weight based on 100 parts by weight flour.

6. The crust of claim 1 wherein said novel starch is present in said dough in an amount of about 5 parts by weight based on 100 parts by weight flour.

7. A method for improving the freezer resistance of a pizza crust, comprising the steps of:

(a) forming a dough comprising flour, yeast, water and an effective amount of a novel starch obtained from a plant having a genotype selected from the group consisting of amylose extender dull, dull horny, dull sugary-2 and dull waxy, the amount being effective to improve the freezer resistance of the pizza crust; and

(b) shaping and baking said dough into a pizza crust.

8. The method of claim 7 wherein additional water in an amount of about 20 to about 80 parts by weight based on 100 parts by weight of novel starch is added to the dough.

9. The method of claim 7 wherein said novel starch is obtained from maize.

10. The method of claim 7 wherein said novel starch is in granular form.

11. The method of claim 7 wherein said novel starch is present in said dough in an amount of about 1 part to about 15 parts by weight based on 100 parts by weight flour.

12. The method of claim 7 wherein said novel starch is present in said dough in an amount of about 2 parts to about 10 parts by weight based on 100 parts by weight flour.

13. The method of claim 7 wherein said novel starch is present in said dough in an amount of about 5 parts by weight based on 100 parts by weight flour.

## EXHIBIT 12



US005120562A

**United States Patent** [19]

Furcsik et al.

[11] **Patent Number:** **5,120,562**[45] **Date of Patent:** **Jun. 9, 1992**[54] **AEDU BATTER STARCH FOR DEEP FAT  
FRIED FOOD**[75] **Inventors:** Susan L. Furcsik, Lake Station, Ind.;  
Edward D. DeBoer, Sauk Village, Ill.[73] **Assignee:** American Maize-Products Company,  
Hammond, Ind.[21] **Appl. No.:** 627,556[22] **Filed:** Dec. 10, 1990**Related U.S. Application Data**

[63] Continuation of Ser. No. 393,283, Aug. 11, 1989, abandoned.

[51] **Int. Cl.<sup>5</sup>** ..... A21D 10/04; C08B 31/02;  
C08B 30/00[52] **U.S. Cl.** ..... 426/549; 127/32;  
127/65; 127/71; 426/658; 426/661; 536/102;  
536/107; 536/110[58] **Field of Search** ..... 426/549, 658, 661;  
127/32, 38, 39, 40, 65, 71; 536/102, 107, 110[56] **References Cited****U.S. PATENT DOCUMENTS**

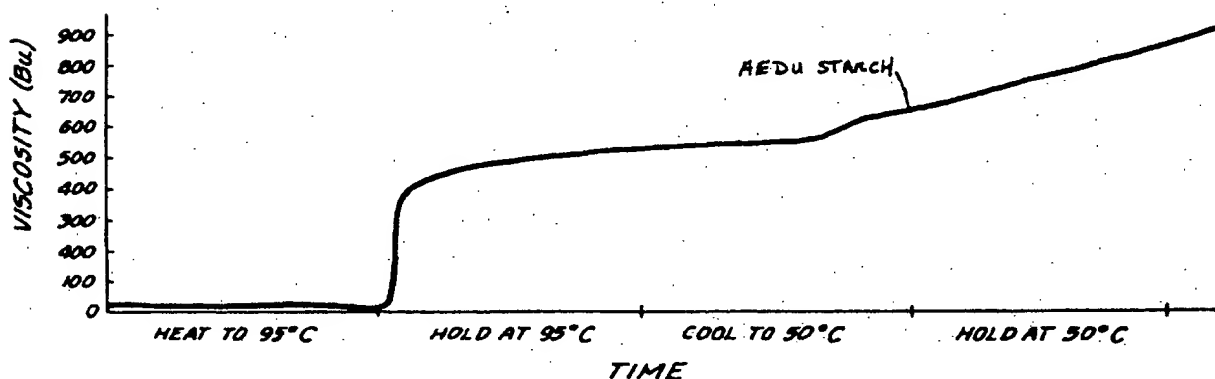
3,655,443	4/1972	Campbell	127/70
4,218,485	8/1980	Lee et al.	426/296
4,595,597	6/1986	Lendrin et al.	426/555
4,790,997	12/1988	Freidman et al.	426/578

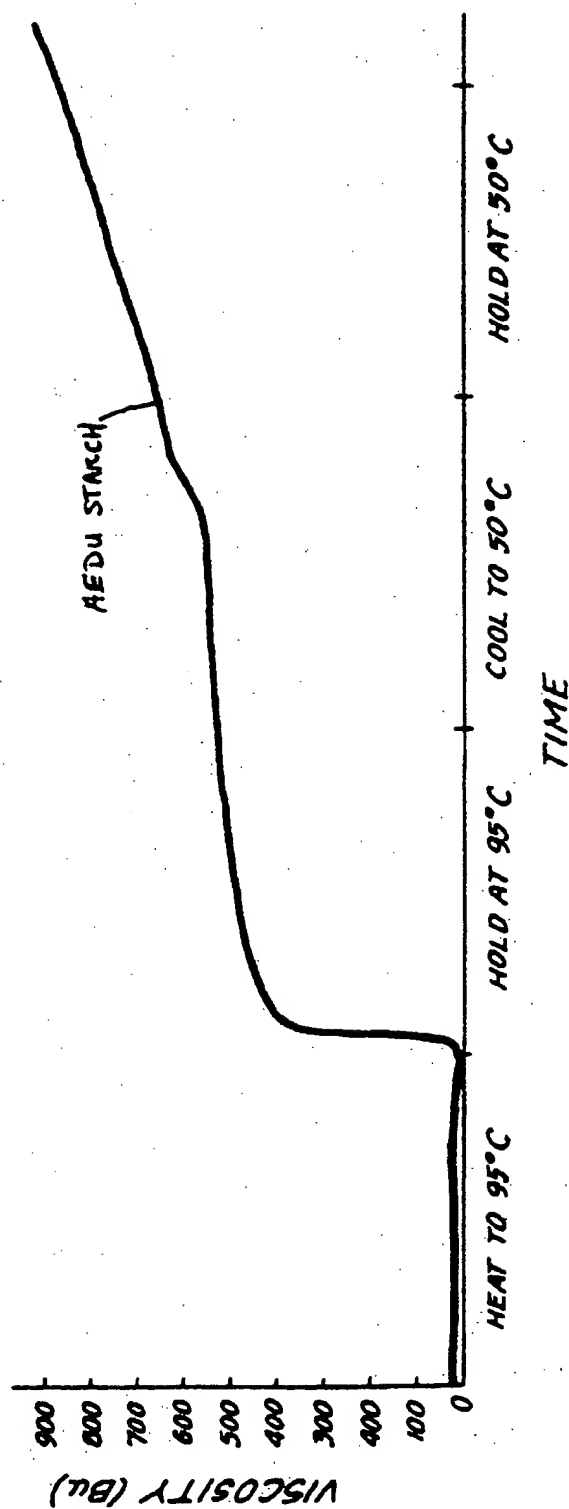
*Primary Examiner*—Donald E. Czaja*Assistant Examiner*—Evan Federman*Attorney, Agent, or Firm*—Lucas & Just

## [57]

**ABSTRACT**

The batter starch is esterified to have a degree of substitution between 0.02 and 0.1, and a protein content greater than or equal to 1%. The starch is obtained from a starch bearing plant of the aedu homozygous genotype. Maize is the preferred source for the starch and the preferred protein source is gluten. The preferred esterification agent is acetic anhydride.

**20 Claims, 1 Drawing Sheet**



## AEDU BATTER STARCH FOR DEEP FAT FRIED FOOD

This is a continuation of application Ser. No. 393,283 filed Aug. 11, 1989, now abandoned.

This invention relates to a new batter starch for deep fat fried food and more particularly for fried foods that are frozen and subsequently reheated in a microwave oven. The batter starch of the present invention is an esterified aedu starch with a protein content greater than or equal to about 1.0 percent by weight dry starch.

Conventionally, deep fat fried foods are prepared by coating a foodstuff with a batter mix and then breading the batter coated foodstuff with a breading mix. Sometimes the foodstuff is dusted with a dry mix prior to dipping.

Typically, batter mixes contain starch and cereal flour. Mildly oxidized starches, thin boiled starches, cross-linked starches and acetylated starches have also been tried in batter mixes. U.S. Pat. No. 3,655,443 issued Apr. 11, 1972 teaches using an oxidized starch having a protein content greater than 0.7 percent by weight. This oxidized starch was found to lead to better adhesion of the breaded batter coating to the foodstuff.

It has now been discovered that an esterified aedu starch having a low degree of substitution and a protein content greater than or equal to about 1.0 percent by weight dry starch provides good adhesion of a breaded batter coating to foodstuff and produces a crunchy and crispy breaded batter coating. The batter starch of the present invention has also been found to produce a crunchy and crispy breaded batter coating to deep fat fried food which was subsequently reheated in a microwave oven. The preferred batter starch of the present invention is esterified with acetic anhydride to a degree of substitution (DS) between about 0.02 to about 0.1.

The batter starch of the present invention is useful as an ingredient in a batter mix for foodstuffs that are subjected to deep fat frying and then served immediately after frying; or foodstuffs that are prefried, frozen and then reheated after freezing such as by refrying, heating in a conventional oven or heating in a microwave oven.

The present invention may be used to advantage whenever it is desired to coat a foodstuff with a breading mix. The term "breading mix" will be understood by those skilled in the art to mean any mix which is applied to foodstuffs before deep fat frying. Such mixes include bread crumbs, cookie crumbs, cracker crumbs and the like, either alone or mixed with butter, salt, seasoning, etc. The term "foodstuff" means any food which can be deep fried, such as meats, fish, shellfish, fowl, vegetables, etc.

Broadly, a batter mix made in accordance with the present invention comprises water; and an effective amount of an esterified starch, said starch obtained from a starch bearing plant having an amylose extender dull (aedu) homozygous genotype, said esterified starch having a degree of substitution between about 0.02 to about 0.1, and a protein content of greater than or equal to about 1.0 percent by weight dry starch. Preferably, enough batter starch of the present invention is combined with water to produce a batter mix with a solids content between about 25 to about 50% by weight. Good results have been obtained with a batter mix having a solids content of about 40% by weight.

Any plant that produces edible starch and can be crossbred to produce a plant that is an aedu homozygous genotype may be used to provide the aedu starch. Plants that produce edible aedu starch are obtained not only by standard plant cross-breeding techniques but also by moving the aeaedudu genotype to another portion of the plant genome by translocation, inversion or other methods of chromosome engineering. The preferred plant source is maize.

Generally, to obtain a starch bearing plant with both double recessive mutants of the ae and du genotype, a plant having the ae mutant is crossed with a plant having a du mutant and thereafter inbred to obtain a plant homozygous in aedu. After the homozygous aedu genotype is obtained, standard breeding techniques are used to obtain hybrid vigor. Hybrids are preferred because of their starch yield compared to inbred lines. The method of cross-breeding plants, obtaining specific genotype in the offspring, and breeding to obtain hybrid vigor is well-known.

Extraction of the starch from the plant is done in a conventional manner. With the preferred plant source, maize, extraction of the aedu starch from the kernels is done preferably in a conventional corn wet milling operation. Corn wet milling entails the successive steps of steeping the kernels, grinding the kernels and then separating the starch from the other components of the kernel, i.e. germ, hull, gluten and corn oil.

U.S. Pat. No. 4,790,997 issued Dec. 13, 1988 teaches using aedu starch as a thickener for foods. Typical physical characteristics of aedu starch extracted from maize are as follows:

Apparent Amylose	53%
Gelatinization Temp.	69.5° C.
<u>Brabender Amylogram</u>	
Initial Rise	92° C.
Heating Peak	535 BU
Heating Final	535 BU
Cooling Peak	960 BU
Cooling Final	960 BU

The percent amylose was determined using standard colorimetric iodine procedures wherein the starch is first gelatinized with sodium hydroxide and then reacted with an iodine solution. The resulting sample is measured using a spectrophotometer in a 1 cm cell at 600 nm against a blank of 0.2% iodine solution.

The gelatinization temperature was measured using a scanning calorimeter, Mettler Model No. 300, using a 30% solids starch following the procedure outlined in the owner's manual for that model.

The Figure illustrates a Brabender amylogram of the aedu starch run at 12% solids content using a 90 gram sample with 125 gram cartridge at 100 rpm. The exact procedure used is outlined in the Amylograph Handbook of the American Association of Cereal Chemists, 1982 edition at pages 17 and 18. The respective paddle for the 90 gram cup was used.

The initial rise was the temperature at which the pen moves away from the baseline.

The sample started at room temperature and the rapid heat mode of the instrument was used to heat the sample to 50° C. Once 50° C. was reached, the instrument was set at a controlled rate of heating, 1.5° C./minute, until a temperature of 95° C. was reached. The sample was then held at 95° C. for 30 minutes. During this period of heating, the highest viscosity obtained by the sample

was labeled Heating Peak. The Heating Final was the last viscosity obtained by the sample at the end of the heating cycle. Next, the sample was cooled at 1.5° C./minute to a temperature of 50° C. The sample was then held at 50° C. for 30 minutes. The largest viscosity measurement taken during this cooling cycle was the Cooling Peak and the final viscosity at the end of the cooling cycle was the Cooling Final.

Brabender curves are a well-known tool for determining characteristics of starch.

The protein used to adjust the protein content of the aedu starch can be of either animal or vegetable origin. As a general rule, however, it is preferred to use a protein derived from the same material as the starch, e.g. add corn protein (corn gluten) to corn starch. Normal commercial starches have a protein level of approximately 0.2 to 0.6% and it is necessary to adjust this level to greater than or equal to about 1.0% protein by weight dry starch. This adjustment in the protein level of the starch can be made by any suitable method. One suitable method is the simple addition of protein. A second suitable method to adjust the protein content is to combine a starch with a high protein content with one which has a low protein content such that the resulting mixture has the desired protein level. A third method especially applicable to corn starch is simply to reduce the amount of gluten that is normally removed during the extraction process of starch from corn kernels.

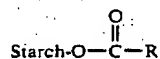
The protein content of starch is increased to greater than or equal to about 1.0% by weight dry starch. Preferably the protein level in the starch is increased to between about 1.0 to about 11% by weight based on dry starch. Good results have been obtained by adjusting the protein content to about 1 to about 2% by weight dry starch.

Preferably, gluten is added to adjust the protein content to greater than or equal to about 1.0% by weight dry starch. More preferably, about 1.0 to about 5% by weight dry starch of gluten is added. Good results have been obtained by adding about 1% by weight dry starch of corn gluten to adjust the protein content of the starch. The protein content of a starch is suitably measured in accordance with The Standard Analytical Method B-48 Corn Refiners Association Standard Nov. 26, 1956, Revised June 25, 1980.

The esterified aedu starch of the present invention has a degree of substitution (DS) of about 0.02 to about 0.10, and more preferably about 0.06 to about 0.10. Good results have been obtained with aedu starch having a DS between about 0.07 to about 0.08. Degree of substitution is determined in a conventional manner using The Standard Analytical Method C-2 Corn Refiners Association Tentative Standard May 27, 1968.

In order to esterify the aedu starch granules, a slurry of starch is prepared having about 5 to about 40% by weight starch. The pH of the slurry is then adjusted to about 8 to about 10 and an esterification agent is added to the slurry such as vinyl ester, acetyl halides, or acid anhydrides such as acetic anhydride or succinic anhydride. The esterification agent is added quickly while maintaining the pH of the slurry. The reaction is continued for about 0.01 to about 5 hours at about 80° F. (27° C.) to about 120° F. (50° C.). Once the reaction is completed to the desired degree of substitution, the slurry is neutralized, dewatered, washed and dried.

Preferably, the aedu starch granules are reacted with the esterification agent to produce an esterified starch having the structural formula:



wherein R is selected from the group consisting of alkyl, alkylene, hydroxyalkyl, hydroxyalkylene, alkanolic acid, and contains one to six carbons. Good results have been obtained when R is a methyl group, i.e. acetylated starch.

Acetylation of the aedu starch granule is conducted in an aqueous medium in a conventional manner to obtain the appropriate DS. Appropriate acetylating agents include vinyl acetate and acetic anhydride. Suitable catalysts are sodium hydroxide, calcium hydroxide and sodium carbonate.

Preferably, acetylation of the aedu starch is conducted by preparing a slurry of aedu starch granules in water at a solids content of between about 30 to about 35% by weight dry starch. The pH of the slurry is adjusted to between about 8 to about 11 by the addition of calcium hydroxide. The amount of calcium hydroxide, corresponding to a molar ratio of calcium hydroxide to esterification agent of about 0.8 to 1, is added to the slurry and mixed thoroughly with the starch granules for about 30 minutes. The esterification agent, acetic anhydride, is added as quickly as possible to the well-stirred slurry, whereupon the pH falls to the desired range of about 5.0 to about 5.5. Acetic anhydride is added to the slurry in an amount to obtain the desired DS. If necessary, acid is added after 1 to 3 minutes of reaction to reduce pH to the desired range. Once the reaction is complete, the slurry is neutralized and dewatered. The acetylated starch is then washed and dried. The protein content of the starch can be adjusted prior to acetylating or after acetylating the starch.

The batter mix of the present invention is prepared by combining water and the batter starch of the present invention. Good results have been obtained by mixing the water into the batter starch but any conventional process may be employed.

Preferably, the foodstuff is dusted with the starch of the present invention prior to coating the foodstuff with the batter mix of the present invention.

These and other aspects of the present invention may be more fully understood by the following examples:

#### EXAMPLE 1

This example illustrates making an acetylated aedu starch having an adjusted protein content of about 1% by weight dry starch.

A slurry was formed from 3.0 kg of aedu starch granules, protein content 0.59%, and 7 liters of water. To this slurry was added 30 grams of gluten. The gluten was a mixture of gluten extracted from common corn and waxy corn kernels. Next, 150 grams of reagent grade calcium hydroxide (Ca(OH)<sub>2</sub>) was added to the slurry to adjust the pH of the slurry to about 12%. The slurry was mixed for 30 minutes to get good dispersion of the calcium hydroxide. Next, 260 grams of industrial grade acetic anhydride was added quickly to the slurry, while mixing continued. About one minute after the addition of all the anhydride, the pH of the slurry was adjusted to approximately 5 to terminate the reaction. The slurry was then subjected to the subsequent wash

steps of dewatering, reslurrying and dewatering. Finally, the product was dried in a fluidized bed dryer.

The resulting starch had a DS of 0.075 and a protein content of 1.05% by weight dry starch.

### EXAMPLE 2

This example illustrates another way of making the starch of the present invention.

Following a procedure similar to the one outlined in Example 1 above, an acetylated aedu starch was made. However, this time no gluten was added to the slurry. The resulting acetylated starch had a DS of 0.075 and a protein content of 0.59% by weight dry starch. To this acetylated starch 1% by weight gluten was added to raise the protein content of the starch to about 1%.

### EXAMPLE 3

This example illustrates the good adhesion of the batter starch of the present invention.

TABLE

	SAMPLE			
	A	B	C	D
Starch	aedu	aedu	high amylose corn starch	high amylose corn starch
DS (acetyl)	0.075	0.075	0.094	0.094
% Protein	0.59	0.59	0.8	0.8
Initial				
% Gluten added	1.0	0	1.0	0
% Protein Final	1.05	0.59	1.13	0.8
Results of Fry				
sides	very crisp + crunchy	crisp + crunchy	crunchy + crisp	crisp
center	very crisp + crunchy	crisp + crunchy	soft	soft
bottom	very crisp + crunchy	crisp + crunchy	soft	soft
Adhesion of Batter	very good	good	fair	fair

Four samples A-D of fillets of fish weighing approximately 4 oz. (120 g) were prepared.

Sample A was dusted and then battered with the acetylated aedu starch of the present invention. Both the dusting medium and the batter mix contained the starch of Example 2 above. The protein content was adjusted by the addition of gluten.

Sample B was dusted and battered with a batter mix, both the dusting medium and batter mix containing acetylated aedu starch without having its protein content adjusted.

Sample C was dusted and dipped into a batter mix, both the dusting medium and batter mix made from a high amylose corn starch sold under the name AMAIZO 5® by American Maize-Products Co. of Hammond, Ind. The amylose content was about 50%. The AMAIZO 5 was acetylated and the protein content was adjusted by addition of gluten.

Sample D was dusted and dipped into a batter mix, both the dusting medium and batter mix made from the acetylated starch used in Sample C, except its protein content was not adjusted.

Each starch was acetylated in a manner as outlined in Example 1 above. The gluten added was corn gluten having a protein content of about 60%.

All samples were prepared by first dusting the foodstuff in the starch, and then thoroughly dipping the dusted foodstuff into a batter mix of 40% solids made of

water and the starch. The battered fillets were then drained and breaded with a breading mix.

Each portion was then deep fat fried in vegetable oil at 191° C. for 3.5 minutes. The fillets were then cooled to about 60° C.

After cooling, adhesion was tested. Finally a taste panel of five tasters tested the fillets to determine how crispy and crunchy they were. It is clear from the above results that the material of the present invention was superior to the others.

It will be understood that the claims are intended to cover all changes and modifications of the preferred embodiment of the invention herein chosen for the purpose of illustration which do not constitute a departure from the spirit and scope of the invention.

What is claimed is:

1. An esterified starch suitable for use in a batter mix for deep fat fried foods characterized in that the starch is obtained from a starch bearing plant having an aedu homozygous genotype, said starch having been esterified to a degree of substitution of between about 0.02 to about 0.10 and having a protein content greater than or equal to about 1.0% by weight dry starch.

2. The starch of claim 1 wherein the starch bearing plant is maize and the protein content is between about 1.0 to about 11%.

3. The starch of claim 1 wherein the starch has been esterified with acetic anhydride.

4. The starch of claim 1 wherein corn gluten has been added to the starch to provide a protein content of about 1 to about 2% by weight dry starch.

5. A batter mix for breaded deep fat fried foods comprising water and an effective amount of an esterified starch characterized in that the starch is obtained from a starch bearing plant having an aedu homozygous genotype, said starch having been esterified to a degree of substitution of between about 0.02 to about 0.10, and having a protein content greater than or equal to about 1.0 percent by weight dry starch.

6. The batter mix of claim 5 wherein the batter mix has a solids level of about 25% to about 50%.

7. A method for producing an esterified starch suitable for use in a batter mix for deep fat fried foods comprising the steps of:

a) adjusting the protein content of a starch obtained from a starch bearing plant having an aedu homozygous genotype to greater than or equal to about 1.0 percent by weight dry starch; and

b) esterifying the starch with an esterification agent to a degree of substitution of about 0.02 to about 0.10.

8. The method of claim 7 wherein the starch bearing plant is maize.

9. The method of claim 7 wherein the protein content is adjusted to between about 1.0 to about 11% by weight dry starch.

10. The method of claim 7 wherein the protein content is adjusted by the addition of corn gluten.

11. The method of claim 7 wherein the esterification agent is acetic anhydride.

12. The batter mix of claim 5 wherein the starch bearing plant is maize.

13. The batter mix of claim 5 wherein the protein content is between about 1.0 and about 11%.

14. The batter mix of claim 5 wherein the starch has been esterified with acetic anhydride.



15. The batter mix of claim 5 wherein corn gluten is added to the starch to provide a protein content of about 1 to about 2% by weight dry starch.

16. The batter mix of claim 12 wherein the protein content is between about 1 and 2%.

17. The batter mix of claim 12 wherein corn gluten is added in an amount of about 1 to about 5% by weight dry starch to provide a protein content greater than or equal to 1.0%.

18. The batter mix of claim 12 wherein the starch is esterified with acetic anhydride to a degree of substitution of about 0.06 to about 0.10; and the protein content is between about 1.0 and about 11%.

19. The batter mix of claim 12 wherein the starch is esterified with acetic anhydride and corn gluten is added to provide a protein content between about 1 and about 11%.

20. The batter mix of claim 18 wherein the batter mix has a solids level of about 25% to about 50%.

\* \* \* \* \*

15

20

25

30

35

40

45

50

55

60

65

## EXHIBIT 13

# United States Patent [19]

Furcsik et al.

[11] Patent Number: 5,035,912

[45] Date of Patent: Jul. 30, 1991

[54] STARCH JELLY CANDY

[75] Inventors: Susan L. Furcsik, Lake Station, Ind.;  
David J. Mauro, Dolton, Ill.

[73] Assignee: American Maize-Products Company,  
Stamford, Conn.

[21] Appl. No.: 540,360

[22] Filed: Jun. 19, 1990

[51] Int. Cl.<sup>5</sup> ..... A23G 3/00; A23L 1/0522

[52] U.S. Cl. .... 426/578; 426/658;  
426/660

[58] Field of Search ..... 426/578, 658, 660

[56] References Cited

## U.S. PATENT DOCUMENTS

3,218,177	11/1965	Robinson et al. ....	426/578
3,265,508	8/1966	Wurzburg et al. ....	426/578
3,265,509	8/1966	Wurzburg et al. ....	426/578
3,446,628	5/1969	Schoch et al. ....	426/578
3,687,690	8/1972	Moore ..... ..	426/578
4,073,959	2/1978	Durand ..... ..	426/578
4,120,987	10/1978	Moore ..... ..	426/660
4,225,627	9/1980	Moore ..... ..	426/660
4,428,972	1/1984	Wurzburg et al. ....	426/578
4,567,055	1/1986	Moose ..... ..	426/660
4,704,293	11/1987	Moore et al. ....	426/660
4,726,957	2/1988	Lacourse et al. ....	426/660
4,770,710	9/1988	Friedman et al. ....	426/658
4,774,328	9/1988	Friedman et al. ....	426/658

4,789,557	12/1988	Friedman et al. ....	426/578
4,790,997	12/1988	Friedman et al. ....	426/578
4,792,458	12/1988	Friedman et al. ....	426/578
4,798,735	1/1989	Friedman et al. ....	426/578
4,874,628	10/1989	Eden et al. ....	426/578
4,886,678	12/1989	Chiu et al. ....	426/658

## OTHER PUBLICATIONS

"A Text Book on Candy Making" by Alfred E. Leighton, The Manufacturing Confectioner Publishing Company, Copyright 1952—Lesson 8—Pectin Jellies and Their Manufacture—pp. 78–103.

Primary Examiner—Jeanette Hunter  
Attorney, Agent, or Firm—Lucas & Just

[57] ABSTRACT

A starch jelly candy is made from a starch jelly formulation of a starch composition of a first starch from a plant having a dull horny (duh) homozygous genotype and a second starch obtained from a plant having a homozygous genotype selected from the group consisting of amylose extender dull (aedu), amylose extender sugary-2 (aesu2), amylose extender dull shrunken-1 (aedushl), dull sugary-2 (dusu2), and mixtures thereof; a sweetener; and water. the mixture is cooked at the temperature of 240° F. (116° C.) instead of the conventional cooking temperature of 340° F. (170° C.).

18 Claims, No Drawings

## STARCH JELLY CANDY

This invention relates to a starch jelly candy made from a formulation having as an essential ingredient therein a starch composition comprising a first starch obtained from a plant having a dull horny (duh) homozygous genotype and a second starch obtained from a plant having a homozygous genotype selected from the group consisting of amylose extender dull (aedu), amylose extender sugary-2 (aesu2), amylose extender dull shrunken-1 (aedushl), dull sugary-2 (dusu2), and mixtures thereof.

Starch jelly candy, also known as jelly gum confections, gum drops, gum slices, fruit gums, or jelly beans, is typically made from a starch jelly candy formulation of a sweetener, a starch composition and water. The starch composition provides texture and body to the starch jelly candy as well as water retention properties. Typically, the starch composition comprises a conventional high amylose starch and a thin-boiled starch. Conventional high amylose starch contains at least 40% amylose and is obtained from a starch-bearing plant having a homozygous genotype of amylose extender amylose extender (aeae). Thin-boiled starch is a starch which has been chemically treated with an acid in order to decrease the viscosity of a slurry made with the starch. See, for example, U.S. Pat. Nos. 3,218,177 issued Nov. 16, 1965; 3,265,509 issued Aug. 9, 1966; and 4,726,957 issued Feb. 23, 1988.

Typically, starch jelly candies are made by cooking the starch jelly candy formulation at a temperature of about 340° F. (170° C.); depositing the cooked, homogeneous mixture into molds; and cooling the homogeneous mixture in the molds to form a solid, homogeneous starch jelly candy.

One problem associated with conventional starch jelly candies is the large amount of energy needed to fully gelatinize and cook the high amylose starch. There is a need in the candy industry to decrease the amount of energy needed to manufacture starch jelly candy.

Additionally, there is a trend in the food industry to eliminate chemically modified or treated starches such as thin-boiled starches. There is a large consumer market for "natural" food and thus a desire by the food manufacturer to use as many non-altered components in their food formulations as possible in order to satisfy the market demand for "natural" food.

It has now been discovered that a starch jelly candy can be made without a chemically modified starch and with a reduction in the amount of energy needed to make the starch jelly candy. Such is made possible by employing a starch jelly candy formulation which contains a starch composition comprising a first starch obtained from a plant of the dull horny (duh) homozygous genotype, and a second starch obtained from a plant having a homozygous genotype selected from the group consisting of amylose extender dull (aedu), amylose extender sugary-2 (aesu2), amylose extender dull shrunken-1 (aedushl), dull sugary-2 (dusu2) and mixtures thereof.

A starch jelly candy formulation according to the present invention comprises the starch composition of the present invention, a sweetener, and water. Flavorings and coloring components can also be added. In order to make a starch jelly candy in accordance with the present invention, a starch jelly formulation is

cooked, deposited into molds and cooled to form a solid starch jelly candy.

It has been found that, by employing the starch jelly formulation containing the starch composition of the present invention, a cooking temperature of about 240° F. (116° C.) or lower may be employed. The decrease of cooking temperature from 340° F. (170° C.) to 240° F. (116° C.), i.e. the decrease of 100° F. (38° C.) in the cooking temperature, translates into savings of energy and time during processing of the starch jelly candy formulation. In addition, there is decreased time needed to cool the formulation once it has been molded.

The starch composition of the present invention employs two or more non-converted, natural starches while still obtaining the organoleptic characteristics such as taste, mouth feel, body and texture, of a starch jelly candy made from a conventional starch composition of high amylose and thin-boiled starch. The starch composition of the present invention satisfies the need for a more "natural" food. Additionally, the starch composition of the present invention also provides similar water retention characteristics of the conventional starch composition.

In addition to satisfying the market's desire for a more natural product, there are cost benefits to using a non-chemically modified starch product.

Preferably, the starch composition of the present invention comprises about 10% to about 90% by weight of the first starch and about 90% to about 10% by weight of the second starch. More preferably, the starch composition of the present invention comprises about 30% to about 70% by weight of the first starch and about 70% to about 30% by weight of the second starch. Good results in accordance with the present invention have been obtained using a starch composition comprising about 50% by weight of the first starch and about 50% by weight of the second starch. The amounts are based on either dry or wet basis, so long as the same basis is used for each starch.

Preferably, the amount of the starch composition of the present invention used in the starch jelly formulation is about 1% to about 25% by weight of the starch formulation of the present invention. More preferably it comprises about 5% to about 20% by weight. Good results have been obtained using about 10% to about 15% by weight.

The amount of sweetener used varies depending on the desired sweetness and the other ingredients used in the starch jelly candy. Suitably, the starch jelly formulation of the present invention contains about 25% to about 75% by weight sweetener.

Water is added to the starch jelly formulation as need to dissolve the solid components of the formulation. Water is suitably added in the amount of between about 20% and 75% by weight of formulation.

The term "starch" as used in the specification and claims herein means not only the substantially pure starch granules as extracted from a starch-bearing plant but also grain products of the starch granule such as flour, grit, hominy, and meal, so long as these starches have not been chemically modified or treated to substantially alter the makeup of the anhydroglucose monomeric units or the polymeric structure of the starch.

Any plant source which produces edible starch and which can be crossbred to produce a plant having a duh, an aedu, an aedushl, an aesu2 or a dusu2 homozygous genotype may be used to obtain the starches which are used to make a starch jelly candy in accordance

with the present invention. It has been found that the amylose extender (ae) gene is present in maize and barley, and that cereal grains such as maize contain the dull (du), horny (h), sugary-2 (su2), and shrunken (shl) genotypes. Maize is the preferred plant source for the starches used in the present invention.

The terms "dull horny" or "duh" genotype as used in the specification and claims mean not only the duh homozygous genotype, duduhh, which has been obtained by standard plant breeding techniques, but also the duh genotype which has been moved to another portion of the plant genome by translocation, inversion, or any other method of chromosome engineering to include variations thereof whereby the disclosed properties of the starch used in the present invention are obtained.

The terms "amylose extender dull" or "aedu" genotype as used in the specification and claims mean not only the aedu homozygous genotype, aeaedudu, which has been obtained by standard plant breeding techniques, but also the aedu genotype which has been moved to another portion of the plant genome by translocation, inversion, or any other method of chromosome engineering to include variations thereof whereby the disclosed properties of the starch used in the present invention are obtained.

The terms "amylose extender sugary-2" or "aesu2" genotype as used in the specification and claims mean not only the aesu2 homozygous genotype, aeaesu2su2, which has been obtained by standard plant breeding techniques, but also the aesu2 genotype which has been moved to another portion of the plant genome by translocation, inversion, or any other method of chromosome engineering to include variations thereof whereby the disclosed properties of the starch used in the present invention are obtained.

The terms "amylose extender dull shrunken-1" or "aedushl" genotype as used in the specification and claims mean not only the aedushl homozygous genotype, aeaedudushlshl, which has been obtained by standard plant breeding techniques, but also the aedushl genotype which has been moved to another portion of the plant genome by translocation, inversion, or any other method of chromosome engineering to include variations thereof whereby the disclosed properties of the starch used in the present invention are obtained.

The terms "dull sugary-2" or "dusu2" genotype as used in the specification and claims mean not only the dusu2 homozygous genotype, dudusu2su2, which has been obtained by standard plant breeding techniques, but also the dusu2 genotype which has been moved to another portion of the plant genome by translocation, inversion, or any other method of chromosome engineering to include variations thereof whereby the disclosed properties of the starch used in the present invention are obtained.

The terms "duh starch", "aedu starch", "aesu2 starch", "aedushl starch" and "dusu2 starch" as used in the specification and claims mean starches obtained respectively from starch-bearing plants which are of the duh, aedu, aesu2, aedushl, and dusu2 genotypes.

U.S. Pat. Nos. 4,774,328 issued Sept. 27, 1988; 4,790,997 issued Dec. 13, 1988; 4,798,735 issued Jan. 17, 1989; 4,770,710 issued Sept. 13, 1988; and 4,792,458 issued Dec. 20, 1988 disclose, respectively, the duh, aedu, aesu2, aedushl, and dusu2 starches and their use in foodstuffs. These patents are incorporated herein by reference.

The sweetener used in the starch jelly formulation of the present invention suitably comprises corn syrup having a DE between about 30 to about 90 and a sugar component. The sugar component can be conventional sugars such as monosaccharides, disaccharides, or trisaccharides. Suitable monosaccharides include glucose, fructose, ribose, arabinose, mannose, xylose, galactose, or mixtures thereof. Suitable disaccharides include sucrose, maltose, cellobiose, lactose, trehalose, or mixtures thereof. Suitable trisaccharides include maltotriose, raffinose, cellotriose, manninotriose, or mixtures thereof. The sugar component of the sweetener can also be a high intensity sweetener such as saccharine aspartame or Acesulfame-K. The sugar component can be mixtures of various conventional sugars and/or high-intensity sweeteners. It is preferred to use sucrose as the sugar component of the sweetener.

The sweetener suitably comprises about 20% to about 90% by weight corn syrup and about 80% to about 10% by weight of the sugar component. It is preferred to use about 30% to about 80% by weight corn syrup and about 70% to about 20% by weight of the sugar component. It is most preferred to use about 40% to about 70% by weight corn syrup and about 60% to about 30% of the sugar component.

A flavoring and coloring component such as natural flavorants, artificial flavorants, coloring agents, fats, oils, surfactants, humectants, vitamins, or preservatives can also be included in the starch jelly candy of the present invention.

The natural flavorant can be a fruit flavorant such as a fruit puree, a fruit puree concentrate or dehydrated fruit solids. The natural flavorant can also be a spice flavorant.

If the flavoring and coloring component is used to make the starch jelly candy, it can be added in the amount of up to about 10% by weight to the starch jelly formulation. Preferably, the starch jelly candy formulation contains about 0% to about 10% by weight of a flavoring and coloring component.

In order to make a starch jelly candy in accordance with the present invention, first the components of the formulation are combined and stirred together in a container and the contents of the container are heated up to about 280° F. (140° C.). During the heating step, the formulation is stirred. After heating, the starch jelly candy formulation is deposited into a mold. Except for the reduced temperature at which the contents are cooked, as compared to conventional cooking temperatures for starch jelly candies, the steps for forming the starch jelly candy are conventional and conventional equipment can be employed.

More specifically, a starch jelly candy is made in accordance with the present invention by making a formulation of water, corn syrup, sugar and as an essential ingredient therein a starch composition comprising a first starch from a plant of the dull horny (duh) homozygous genotype, and a second starch obtained from a plant having a homozygous genotype selected from the group consisting of amylose extender dull (aedu), amylose extender sugary-2 (aesu2), dull shrunken-1 (aedushl), dull sugary-2 (dusu2), and mixtures thereof. Next, the formulation is heated to a temperature of about 240° F. (116° C.) while the formulation is constantly stirred to form a homogeneous mix. Any conventional piece of equipment, for example a jacketed kettle equipped with an impeller or a jet cooker, is used to heat and mix the formulation. Once the formulation

has reached 240° F. (116° C.), the formulation is deposited into at least one starch mold where the hot mix is allowed to set. A formulation made in accordance with the present invention sets in a temperature range of 90° F. (30° C.) to 120° F. (50° C.). Setting is accomplished in a conventional manner. After setting, the candies are removed from the mold. Starch molds are conventional.

It will be understood by those of skill in the art that the temperature to which the starch jelly candy formulation of the present invention is heated can be higher than 240° F. (116° C.) without having a deleterious effect on the starch jelly candy.

These and other aspects of the present invention may be more fully understood with reference to the following examples:

#### EXAMPLE 1

This example illustrates a starch jelly candy made in accordance with the present invention compared to a conventional starch jelly candy made using conventional high amylose starch and thin-boiled starch. These starch jelly candies were made from the starch jelly formulation in Table I below:

TABLE I

Ingredients	Starch Jelly Formulation, Amount (% by Weight)	
	PRESENT INVENTION	CONVENTIONAL
44/62 csu*	44.9	44.9
Sugar, Fine Granular (Sucrose)	32.0	32.0
Water	12.4	12.4
duh Starch	7.4	0
aedu Starch	3.1	0
90 Thin-boiled Starch	0	7.4
Amaizo 5** (50% amylose)	0	3.1
Citric Acid	0.1	0.1
Sodium Citrate	0.1	0.1

\*44/62 csu is a corn syrup made from common starch having a DE of 62 and a Baume of 44.

\*\*Amaizo 5 is a corn starch manufactured by American Maize Products Company of Hammond, Indiana.

All ingredients used in the starch jelly candy made in accordance with the present invention were mixed together to form a starch jelly formulation in accordance with the present invention and then heated to 240° F. (116° C.) using a steam jacketed kettle equipped with an impeller.

All ingredients used in the conventional starch jelly candy were mixed together to form a conventional starch jelly formulation and then heated to 325° F. (163° C.) using a jet cooker supplied with 150 psi steam.

In both cases, the cooked slurries were deposited into starch molds and allowed to solidify into a starch jelly candy at ambient pressure and temperature.

The organoleptic characteristics such as taste, mouth feel, texture and body, as well as the water retention characteristics, of each of the starch jelly candies made according to both the conventional formulation and the formulation of the present invention were substantially similar.

#### EXAMPLE 2

This is another example of a starch jelly candy made in accordance with the present invention. The following starch jelly formulation is employed:

TABLE 2

Ingredients	Starch Jelly Formulation	
	Amount (% by Weight)	
44/62 csu	45	
Sugar, Fine Granular (Sucrose)	32	
Water	12.4	
duh Starch	7.4	
aesu2 Starch	1.5	
dusu2 Starch	1.5	
Citric Acid	0.1	
Sodium Citrate	0.1	

In order to make starch jelly candy, all ingredients are mixed to form a starch jelly formulation in accordance with the present invention and then cooked at 240° F. (116° C.). After cooking they are transferred into starch molds and allowed to solidify.

#### EXAMPLE 3

In this example a starch jelly candy is made in accordance with Example 2, except 3.0% by weight of aedu2 starch is substituted for the aedu2 and dusu2 starch component.

#### EXAMPLE 4

In this example a starch jelly candy is made in accordance with Example 2, except 3.0% by weight of aedushl starch is substituted for the aedu2 and dusu2 starch component.

#### EXAMPLE 5

In this example a starch jelly candy is made in accordance with Example 2, except 3.0% by weight of dusu2 starch is substituted for the aedu2 and dusu2 starch component.

#### EXAMPLE 6

In this example a starch jelly candy is made in accordance with Example 2, except 3.0% by weight of a 50:50 mix of aedu starch and aedushl starch is substituted for the aedu2 and dusu2 starch component.

#### Example 7

In this example a starch jelly candy is made in accordance with Example 2, except 3.0% by weight of a 50:50 mix of aedu starch and aedu2 starch is substituted for the aedu2 and dusu2 starch component.

It will be understood that the claims are intended to cover all changes and modifications of the preferred embodiments of the invention herein chosen for the purpose of illustration which do not constitute a departure from the spirit and scope of the invention.

What is claimed is:

1. A starch jelly candy comprising a cooked gelled starch formulation wherein said formulation having contained:

(a) a sweetener;

(b) about 1% to about 25% by weight of a starch composition comprising:

(i) about 10% to about 90% by weight a first starch, said first starch being a starch from a plant of the dully horny homozygous genotype; and

(ii) about 90% to about 10% by weight a second starch, said second starch obtained from a plant having a homozygous genotype and selected from the group consisting of amylose extender dully, amylose extender sugary-2, amylose exten-

der dull shrunken-1, dull sugary-2, and mixtures thereof; and

(c) water.

2. The starch jelly candy of claim 1 wherein said formulation comprises:

about 25% to about 75% by weight of said sweetener; about 20% to about 75% by weight water; and further comprising:

about 0% to about 10% by weight of a flavoring and coloring component.

3. The starch jelly candy of claim 1 wherein said first starch; and said second starch are obtained from maize.

4. The starch jelly candy of claim 2 wherein said sweetener comprises a corn syrup having a DE between about 30 and about 90, and a sugar component selected from the group consisting of monosaccharides, disaccharides, trisaccharides, high intensity sweeteners, and mixtures thereof.

5. The starch jelly candy of claim 4 wherein said monosaccharide is selected from the group consisting of glucose, fructose, ribose, arabinose, mannose, xylose, galactose, and mixtures thereof; said disaccharide is selected from the group consisting of sucrose, maltose, cellobiose, lactose, trehalose, and mixtures thereof; said trisaccharides are selected from the group consisting of maltotriose, raffinose, cellotriose, manninotriose, and mixtures thereof; and said high intensity sweetener is selected from the group consisting of saccharine, aspartame, and Acesulfame-K.

6. The starch jelly candy of claim 4 wherein said sweetener comprises about 20% to about 90% by weight corn syrup and about 80% to about 10% by weight of a sugar component.

7. The starch jelly candy of claim 4 wherein the sugar component is sucrose.

8. The starch jelly candy of claim 2 wherein said flavoring and coloring component is comprised of one or more elements selected from the group consisting of natural flavorants, artificial flavorants, coloring agents, fats, oils, surfactants, humectants, vitamins, or preservatives.

9. The starch jelly candy of claim 8 wherein said natural flavorant is a fruit flavorant selected from the group consisting of fruit purees, fruit puree concentrate and dehydrated fruit solids.

10. A starch jelly candy comprising:

(a) a sweetener;

(b) a flavoring and coloring component;

(c) about 1% to about 25% by weight a starch component comprising:

(i) about 10% to about 90% by weight a first starch, said first starch being a starch from a plant of the dull horny homozygous genotype, and

(ii) about 10% to about 90% by weight a second starch, said second starch obtained from a plant having a homozygous genotype and being selected from the group consisting of amylose extender dull, amylose extender sugary-2, amylose extender dull shrunken-1, dull sugary-2, and mixtures thereof; and

(d) water.

11. The starch jelly candy of claim 10 wherein said first starch; and said second starch are obtained from maize.

12. The starch jelly candy of claim 10 wherein said sweetener comprises a corn syrup having a DE between about 30 and about 90, and a sugar component selected from the group consisting of monosaccharides, disaccharides, trisaccharides, high intensity sweeteners, and mixtures thereof.

13. The starch jelly of claim 12, wherein the sugar component is sucrose.

14. A method for making a starch jelly candy comprising:

(A) forming a starch jelly formulation comprising:

(i) a sweetener;

(ii) about 1% to about 25% by weight a starch component comprising:

(a) about 10% to about 90% by weight a first starch, said first starch being a starch from a plant of the dull horny homozygous genotype, and

(b) about 90% to about 10% by weight a second starch, said second starch obtained from a plant having a homozygous genotype and being selected from the group consisting of amylose extender dull, amylose extender sugary-2, amylose extender dull shrunken-1, dull sugary-2, and mixtures thereof; and

(iii) water;

(B) heating said starch jelly formulation; and

(C) molding said heated starch jelly formulation in candy molds to form starch jelly candy.

15. The method of claim 14 wherein said starch jelly formulation comprises:

about 25% to about 75% by weight of said sweetener; about 20% to about 75% by weight water; and further comprising:

about 0% to about 10% by weight of a flavoring and coloring component.

16. The method of claim 15 wherein said first starch; and said second starch are obtained from maize.

17. The method of claim 14 wherein the starch jelly candy formulation is heated to about 240° F. (116° C.) while constantly stirring the formulation.

18. The method of claim 14 wherein the starch jelly candy is heated to about 240° F. (116° C.) using a jet cooker.

\* \* \* \* \*

UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 5,035,912  
DATED : July 30, 1991  
INVENTOR(S) : Susan L. Furcsik et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 6, line 62, change "dully" to --dull--.

**Signed and Sealed this  
Twenty-ninth Day of December, 1992**

*Attest:*

DOUGLAS B. COMER

*Attesting Officer*

*Acting Commissioner of Patents and Trademarks*



## EXHIBIT 14

# United States Patent [19]

Friedman et al.

[11] Patent Number: 4,790,997

[45] Date of Patent: Dec. 13, 1988

[54] FOOD STUFFS CONTAINING STARCH OF AN AMYLOSE EXTENDER DULL GENOTYPE

[75] Inventors: Robert B. Friedman, Chicago, Ill.;  
David J. Gottneid, Griffith, Ind.;  
Eugene J. Faron, Schererville, Ind.;  
Frank J. Pustek, Munster, Ind.;  
Frances R. Katz, Crown Point, Ind.

[73] Assignee: American Maize-Products Company,  
Stamford, Conn.

[21] Appl. No.: 69,264

[22] Filed: Jul. 2, 1987

[51] Int. Cl.<sup>4</sup> ..... A23L 1/04; A23L 1/195

[52] U.S. Cl. .... 426/578; 426/397;  
426/407

[58] Field of Search ..... 426/578, 579, 589, 658,  
426/549, 935, 397, 407; 127/29, 32; 536/102

[56] References Cited

## U.S. PATENT DOCUMENTS

4,107,338 8/1978 Tutor et al. .... 426/549  
4,428,972 1/1984 Wurzburg et al. .... 426/578

## OTHER PUBLICATIONS

CA 94(21):170612j, Liu, T. T., 1981.  
CA 93(5):41737, Soberalski, R. M., 1980.

CA 92(13):107518b, Garwood, D. L., 1980.

CA 85(13):92388p, Garwood, D. L., 1976.

CA 91(21):171713t, Gentinetta, E., 1979.

84:282833, Biosis, 1983, Inouchi, N.

Genetics and Physiology of Starch Development—  
Chapter III—Jack C. Shannon and Douglas L. Gar-  
wood—pp. 25–85.

Agronomy Journal—vol. 50, (1958)—Gene Interac-  
tions in Maize Affecting Endosperm Properties—H. H.  
Kramer et al., pp. 207–210.

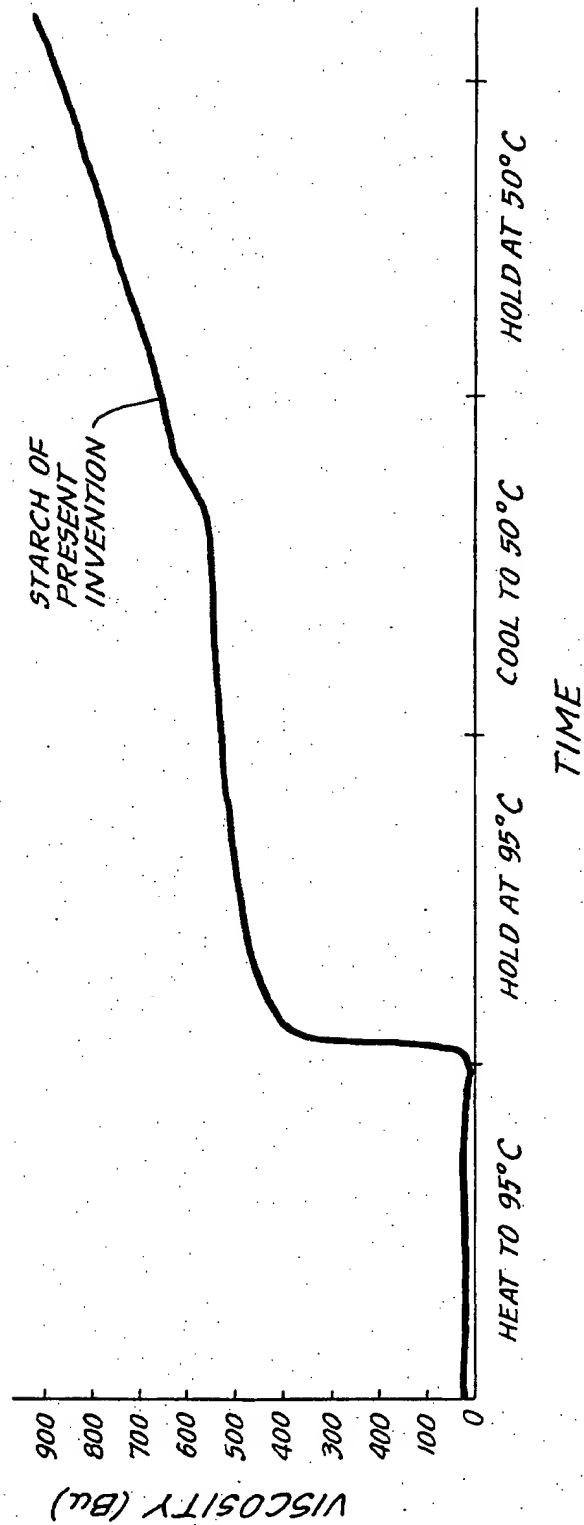
Cereal Chemistry—vol. 39, Nos. 1–6, Jan.–Nov.  
1962—The Digestibility of High-Amylose Corn  
Starches Compared to that of Other Star-  
ches—Rudolph M. Sandstedt et al.—pp. 123–131.

Primary Examiner—Jeanette Hunter  
Attorney, Agent, or Firm—Lucas & Just

[57] ABSTRACT

A thickened foodstuff containing a starch extracted from a starch bearing plant having an amylose extender dull genotype is disclosed. Maize is the preferred plant. The starch exhibits low gelatinization temperature with an amylose content greater than 50%. A method for making the canned foodstuff containing the starch is also disclosed.

10 Claims, 1 Drawing Sheet



## FOOD STUFFS CONTAINING STARCH OF AN AMYLOSE EXTENDER DULL GENOTYPE

This invention relates to starch and more particularly to starch which has been extracted from a plant having an amylose extender dull (aedu) homozygous genotype.

Starch occurs in a variety of plants and is generally categorized based on its plant source. For example, cereal starches are extracted from cereal grains such as maize, rice, wheat, barley, oats and sorghum; tuber and root starches are extracted from plants such as potato, sweet potato, arrowroot, yams and cassava; and waxy starches are extracted from plants such as waxy maize, waxy rice, waxy barley and waxy sorghum.

Generally, starch is comprised of two polymers, amylose and amylopectin which are intertwined to form a starch granule. Amylose is a linear polymer of alpha 1-4 bonded anhydroglucose units while amylopectin is a branched polymer comprised of linear chains of alpha 1-4 linked anhydroglucose units with branches resulting from alpha 1-6 linkages between the linear chains.

Each starch bearing plant produces different percentages of amylose and amylopectin, different size granules and different polymeric weights for both the amylose and amylopectin. These differences produce markedly different properties in the starch.

Heretofore, the only way to affect the properties of starch was to physically and/or chemically treat the starch.

It has recently been discovered that there exists a number of recessive mutant genes in starch bearing plants which have an affect on the properties of starch and that by controlled breeding these mutant genes can be expressed.

Some of the mutant genes which have been identified in maize include the genotypes: waxy (wx), amylose extender (ae), dull (du), horny (h), shrunken (sh), brittle (bt), floury (fl), opaque (o), and sugary (su). Nomenclature for some of these mutant genes is based in part on the effect these mutant genes have on the physical appearance, phenotype, of the kernel. It is also known that within these genotypes there are genes which produce starches with markedly different functional properties even though the phenotypes are the same. Such subspecies have generally been given a number after the named genotype, for example, sugary-1 (su1) and sugary-2 (su2).

One combination of these mutant genes which has been found to possess utility is taught in U.S. Pat. No. 4,428,972 issued January 31, 1984 to Wurzburg et al.

It has now been discovered that a plant having an amylose extender dull (aedu) homozygous genotype will produce a starch having a high amylose content with a gelatinization temperature significantly lower than conventional high amylose starches having comparable amylose content. Specifically, it has been discovered that the starch of the present invention has a gelatinization temperature about 5° C. lower than high amylose starches with comparable amylose content.

It has also been discovered quite unexpectedly that the novel starch of the present invention possesses thin-thick attributes comparable to chemically modified starches used in canning.

FIG. 1 illustrates a Brabender amylogram of the starch of the present invention.

Conventional high amylose starches, amylose content equal to or greater than 50%, have a high gelatinization

temperature, above about 80° C. Such a high gelatinization temperature increases the processing costs associated with conventional high amylose starch.

The discovery of a high amylose starch with a gelatinization temperature below that of conventional high amylose starch can yield a cost savings to the user. Such high amylose starches are especially useful in foods, paper manufacture and fiberglass sizing.

One area of chemically modified starches that has received a great deal of attention is the area of canning starches or thin-thick starches. These starches have a specific utility in canning processes in which high temperatures are obtained rapidly and maintained for sterilization of a foodstuff. The starch is typically added to the foodstuff to provide viscosity to the foodstuff. The name thin-thick is given to these starches because of their viscosity behavior, low or thin viscosity initially to allow rapid heat penetration to facilitate sterilization, increased or thick viscosity after sterilization to add body to the canned foodstuff. The term canning as used in the specification and claims means the act of preserving by heat whether the heat is applied before or after the packaging of the food and regardless of the form of the package. Canning includes for example pouch packaging, canning, aseptic pack and retorting. Generally, thin-thick starches are chemically modified. A thin-thick starch specifically developed for retorting is taught in U.S. Pat. No. 4,120,983 issued October 17, 1978 to del Valle et al. The starch taught by the '983 patent is a hydroxypropylated, epichlorohydrin cross-linked tapioca and corn starch derivative.

The discovery that the starch of the present invention can replace these so-called thin-thick chemically modified starches provides economic advantages.

In order to obtain substantially pure starch in accordance with the present invention, a plant which produces edible starch and has an amylose extender (ae) genotype is crossbred with a plant which produces edible starch and has a dull (du) genotype to produce a plant having an amylose extender dull (aedu) homozygous genotype. The starch is then extracted from this plant. Both the crossbreeding step and the extraction step of the present invention are carried out in a conventional manner.

In order to prepare a sol in accordance with the present invention, a slurry is prepared which comprises water and an effective amount of starch extracted from a plant of the aedu genotype and the slurry is subject to a cooking step. The slurry is cooked as necessary to provide a thickener composition which exhibits characteristics comparable to sols made from conventional high amylose thickener compositions except that less energy is needed to cook the high amylose starch of the present invention compared to the conventional high amylose starch. The preferred amount of starch of the present invention used in the slurry constitutes about 1 to 20% by weight of slurry. Generally, cooking entails raising the temperature of the slurry to above about the gelatinization temperature of the starch and subjecting the starch to enough shear such that the granules rupture and a paste is formed. It is not necessary that all the granules rupture. Conventional high amylose starches are cooked with special equipment such as jet cookers. Using starch of the present invention, such special equipment is not necessary.

A sol or a thickener composition of the starch of the present invention is added to a foodstuff in a conven-

tional manner in order to provide the benefits of high amylose starch to the foodstuff.

Alternatively, starch of the present invention is mixed with a foodstuff or a slurry comprising water and starch of the present invention is mixed with foodstuff and the resulting mixture cooked to produce a thickened foodstuff and to provide the benefits of a high amylose starch to the foodstuff.

In order to replace high amylose or chemically modified starch with starch of the present invention, a replacement ratio of about 1:1, conventional starch:starch of the present invention, may be employed. Larger or smaller amounts of the starch of the present invention may be used to replace the conventional starch.

The starch of the present invention is employed as a thin-thick starch in canning by mixing the starch of the present invention, a slurry or a sol containing the same with a foodstuff suitable for canning. Generally, water is included in this mixture. Conventionally, the pH of such a mixture is adjusted, subsequently sealed in a container and subjected to a conventional canning process. During such canning process, the contents of the container preferably reaches above about 220° F. for a period of about 5 to about 25 minutes thereby sterilizing the contents of the sealed container. The amount of starch of the present invention employed for such a canning process is an effective amount. Preferably, the starch of the present invention is employed in an amount of about 1 to about 20% by weight based on the total weight of the container content. The starch of the present invention, a slurry or a sol containing the same is conventionally mixed with the foodstuff.

The term starch as used in the specification and claims means not only the substantially pure starch granules as extracted from a starch bearing plant but also grain products of the starch granule such as flour, grit, hominy and meal.

The term amylose extender dull or aedu genotype as used in the specification and claims means not only the aedu homozygous genotype, aeaedudu, which has been obtained by standard plant breeding techniques but also the aedu genotype which has been moved to another portion of the plant genome by translocation, inversion or any other method of chromosome engineering to include variations thereof whereby the disclosed properties of the starch of the present invention are obtained.

The term high amylose starch means starch having about 50% and above amylose based on the total weight of amylose and amylopectin in the starch granule. Conventional cereal and tuber and root starches have about 20% by weight amylose, while waxy starches generally have less than about 1% amylose.

Any plant source which produces edible starch and which can be crossbred to produce a plant having a aedu homozygous genotype may be used. It has been found that the amylose extender (ae) mutant gene is present in maize and barley and the dull (du) genotype is present in maize. Maize is the preferred plant source. The amylose extender gene and the dull gene are reported to be located on chromosome 5 and chromosome 10 respectively, of the maize chromosomes. The location of such genes is published in the open literature.

Generally, to obtain a starch bearing plant with both double recessive mutants of the ae and du genotype, a plant of an ae mutant is crossed with a plant having a du mutant and thereafter inbred to obtain a plant homozygous in aedu. After the homozygous aedu genotype is

obtained, standard breeding techniques are used to obtain hybrid vigor. Hybrids are preferred because of their high starch yield compared to inbred lines. The method of crossing plants and of obtaining specific genotypes in the offspring as well as breeding to obtain hybrid vigor is well known.

Extraction of starch from the plant is well known and typically entails a milling process. In accordance with the present invention, a wet milling process is used to advantage to extract the corn starch from the corn kernels. Corn wet milling comprises the steps of steeping and grinding the corn kernel and then separating the starch from the other components of the kernel. Prior to steeping, the kernels are subjected to a cleaning process to remove any debris which may be present. This cleaning process is usually done at the wet milling plant. The kernels are then steeped in a steep tank where the kernels are contacted with a countercurrent flow of water at an elevated temperature of about 120° F. and containing sulfur dioxide in an amount between about 0.1 to about 0.2% by weight water. The kernels are maintained in the steep tank for about 24 to 48 hours. Next, the kernels are dewatered and subject to a first set of attrition type mills.

The first set of mills generally grind and rupture the kernels causing the germ, corn oil, to be released from the rest of the kernel. A typical attrition type mill used in commercial wet milling processes is sold under the brand name Bauer. The released germ is then separated from the other parts of the kernel by centrifugation. Throughout the grinding steps of the wet milling process the kernel and the kernel components are maintained in a slurry of about 40% by weight solids.

The remaining kernel components which include starch, hull, fiber and gluten, are subjected to a second set of attrition type mills such as the Bauer Mill, to further grind the components and separate the hull and fiber from the starch and gluten. Hull and fiber are generally referred to as bran. Washing screens are used to separate the bran from the starch and gluten. The starch and gluten pass through the screens while the bran does not.

Next, the starch is separated from the protein. This step is done either by centrifugation or by a third grind followed by centrifugation. A commercial centrifugation separator suitable for the present process is the Merco centrifugal separator.

The slurry which contains the starch granules is then dewatered and the resulting granules washed with fresh water and dried in a conventional manner preferably to about 12% moisture.

In this manner, the substantially pure starch of the present invention is extracted from a starch bearing plant of the aedu genotype.

Alternatively to the drying step, the starch may be left in suspension and subject to further modification.

Modification of the starch may also be performed on the dried starch. Typically, in order to change the physical and/or chemical structure of the starch granule, the starch is subject to any one or more of eight general treatments. These treatments comprise bleaching, thin boiling, acid treatment, enzyme treatment, dextrinization or dry roasting, etherification, esterification, and crosslinking. Starches which have been treated by any one or more of these eight treatments listed above are conventionally referred to as chemically modified starch.

Bleaching, often referred to as oxidation, is a modification which does not appreciably alter the granular structure of the starch. Oxidation does, however, tend to lighten the color of the granules and reduce the viscosity of the starch paste.

In order to bleach the starch of the present invention, a slurry of starch is prepared of about 5 to about 40% by weight starch. To the slurry sodium hypochlorite is added with about 6% available chlorine (free chlorine) and the slurry is held at about 110° F. for between about 1 to about 20 hours. The slurry is then neutralized with sodium bisulphite and the resulting granules are dewatered, washed and dried in conventional manner.

Such modification makes the starch of the present invention suitable for laundry starch, paper coating and as a textile size.

In order to produce a thin boiled starch of the present invention, a slurry of starch is prepared of about 5 to about 40% by weight starch. To this slurry, a mineral acid is added and allowed to react with the starch for about 1 to about 100 hours at about 90° to about 120° F. with constant agitation. Such a reaction is done below the gelatinization temperature of the starch. Subsequently, the solution is neutralized, dewatered, washed and dried in conventional manner.

Thin boiling leaves the granules intact and produces a starch product which has a slight reduced viscosity compared to the non-thin boiled starch. If partial or total destruction of the starch granule is sought, the granule may be subjected to acid treatment.

In order to acid treat the starch of the present invention, a slurry of starch about 5 to about 40% by weight starch is prepared. This slurry is reacted with acid, generally a strong acid, at a temperature above gelatinization temperature. Such a procedure is preferably carried out by jet cooking the slurry through a conventional jet cooker with or without acid already in the slurry and then allowing the slurry to react with the acid, adding acid if needed, for a desired period of time or until the desired dextrose equivalent (DE) is reached. The DE is roughly proportional to the length of time for the reaction. Generally, such jet cooking destroys the starch's granular structure.

After acid treatment, the resulting slurry is neutralized, dewatered and dried. Such product may also be subject to conventional carbon treatment and filtration prior to dewatering and drying. Another treatment which degrades the granular structure is enzyme treatment.

In order to enzyme treat the starch of the present invention, a slurry of starch is made up having about 5 to about 40% by weight starch. To this slurry, enzyme is added at the optimum pH and temperature for the enzyme. Some advantage is found by first jet cooking the slurry to open up the starch granules, cooling the slurry to optimum temperature for the enzyme and then adding the enzyme. If the enzyme is jet cook stable then the enzyme can be added to the slurry prior to jet cooking. The slurry may also be treated with acid first to a low DE and then enzyme treated. After enzyme treatment, the product is dewatered and dried. Alternatively, the product may be subject to conventional carbon bleaching and filtration prior to concentration and/or drying.

In order to dextrinize or dry roast the starch of the present invention, acid is added to dry starch granules and the mixture is heated to a temperature of about 250° to about 350° F. for about 3 to about 72 hours. The

product, once removed from the heat, is sold as is. The preferred acids are hydrochloric, phosphoric and any mineral acid. Such a method causes the partial breakdown of the granular structure.

In order to etherify the starch of the present invention, a slurry of starch is made up having about 5 to about 40% by weight starch. The pH of the slurry is adjusted to about 10 to about 12 preferably with sodium hydroxide. Next, an etherification agent such as ethylene oxide or propylene oxide is added to the slurry in an amount of about  $\frac{1}{2}$  to about 25% depending on the desired degree of substitution. The reaction conditions are held for about 5 to about 30 hours at about 70° to about 120° F. The slurry is then neutralized with any known acid, dewatered, washed and dried.

In order to crosslink the starch of the present invention, a slurry of starch is made up of about 5 to about 40% by weight starch. The pH of the slurry is adjusted to about 8 to about 12 preferably with sodium hydroxide. Optionally, a salt may be added to the slurry to affect swelling of the granules. Then the slurry is reacted with a crosslinking agent such as phosphorous oxychloride, trimetaphosphate salt, or epichlorohydrin at about 70° to about 120° F. for about  $\frac{1}{2}$  to about 5 hours. The length of time of the reaction will depend on the amount of crosslinking agent used and the specific crosslinking agent chosen.

In order to esterify the starch of the present invention, a slurry of starch is prepared having about 5 to about 40% by weight starch. The pH of the slurry is then adjusted to about 8 to about 10 and an esterification agent is added to the slurry such as vinyl ester, acetyl halides, acid anhydrides like acetic anhydride, or succinic anhydride. The esterification agent is added slowly while maintaining the pH of the slurry. The reaction is continued for about  $\frac{1}{2}$  to about 5 hours at about 80° to about 120° F. Once the reaction is completed to the desired degree of substitution, the slurry is neutralized, dewatered, washed and dried.

Any combination of these modifications may be employed on starch of the present invention.

It has been found that a sol comprising water and an effective amount of starch extracted from a plant of a *aedu* genotype exhibits thickening characteristics which makes the sol a good commercial thickener composition. Such thickener compositions are especially useful in foodstuffs.

The sol is prepared by forming a slurry of water and starch of the present invention and subsequently cooking the slurry thereby forming a paste. Preferably, the sol contains the starch of the present invention in the amount of about 1 to about 20% by weight total sol. The slurry is cooked at a temperature of about 90° C. and above to provide thickening characteristics prior to adding to the foodstuff. Cooking time is about 10 minutes. The sol in accordance with the present invention need not be cooked if the starch has already been subjected to a process which makes it cold water swellable. Cooking generally comprises raising the temperature of an aqueous slurry of the starch of the present invention to the gelatinization temperature of the starch and subjecting the starch to shear such that the starch granules rupture and form a paste.

In order to prepare the thickened foodstuff, a sol made in accordance with the present invention is combined with a foodstuff and the composition is cooked to the necessary degree to provide a thickened foodstuff. Conventional mixing is employed to combine the sol

with the foodstuff. Cooking of the sol and foodstuff composition is also carried out in a conventional manner.

Alternatively, starch of the present invention is mixed with the foodstuff or a slurry comprising the starch of the present invention and water is mixed with a foodstuff and the resulting mixture is cooked to the desired degree to obtain a thickened foodstuff. When the starch itself or a slurry containing the starch itself is mixed with a foodstuff, the resulting mixture must be cooked in order to provide a thickened foodstuff. The mixing as well as the cooking is accomplished in a conventional manner. Cooking is carried out at a temperature of about 90° C. and above. Cooking time is about 10 minutes but may vary depending on the amount of foodstuff present and the amount of shear that the mix is subject to during cooking.

Such a thickener composition provides high amylose characteristics, such as good gel strength, while lowering the temperature needed for cooking as compared to conventional high amylose starches.

These and other aspects of the present invention may be more fully understood with reference to the following examples.

#### EXAMPLE 1

This example illustrates the extraction of the starch of the present invention from an aedu maize kernel produced by conventional crossbreeding and tests the starch to determine its various characteristics. The tests as well as the results obtained therefrom are given in Table I below. The extraction process as well as the test procedures followed are outlined following Table I below:

TABLE I

Test	Present Invention	
	Sample A	Sample B
Percent Protein (dry basis)	0.46%	1.38%
Percent Oil (dry basis)	0.17%	0.09%
Percent Amylose (starch basis)	51.0%	53.0%
DSC Gelatinization Temp.	69.1° C.	69.5° C.
<u>Regular Brabender Amylograms</u>		
Initial Rise	84.5° C.	92° C.
Heating Peak	410 BU	535 BU
Heating Final	380 BU	535 BU
Cooling Peak	1980 BU	960 BU
Cooling Final	1980 BU	960 BU
<u>Acid Brabender Amylograms</u>		
Initial Rise	— °C.	90.5° C.
Heating Peak	— BU	480 BU
Heating Final	— BU	180 BU
Cooling Peak	— BU	2105 BU
Cooling Final	— BU	2105 BU
<u>Brookfield Viscosities (RPMs)</u>		
10	72,000 cps	38,000 cps
20	44,000 cps	33,000 cps
50	22,000 cps	17,600 cps
100	12,600 cps	11,200 cps
50	20,800 cps	14,800 cps
20	43,000 cps	31,000 cps
10	74,000 cps	36,000 cps
<u>Hercules Viscosity (RPMs)</u>		
550	24.36 cps	444.8 cps
1100	15.05 cps	308.83 cps
1650	15.66 cps	238.96 cps
2200	16.06 cps	200.1 cps
1650	19.14 cps	213.99 cps
1100	16.34 cps	253.31 cps
550	25.23 cps	340.55 cps

#### Crossbreeding

In order to perform the crossbreeding process, typically maize plants having the mutant gene ae were

cross-pollinated with maize plants having the mutant gene du. From the mature ears of some of these plants, kernels having aedu homozygous genotype were produced. Such kernels were used to produce starch in accordance with the present invention and to provide seed for future maize plants of the aedu homozygous genotype.

#### Extraction Process

The following extraction process was used to extract the starch from the kernel. Sample A was grown in a dent corn background, OHIO 48, while Sample B was grown from a hybrid cross between a dent corn background of OHIO 48 homozygous for aedu genotype and a dent corn background of W64A homozygous for aedu genotype.

#### Steeping

Steeping was carried out by adding maize kernels to water having a 0.2% SO<sub>2</sub> content and holding the temperature of the steep water at 50° C. for 48 hours. The steep water was circulated through the steep container. After the 48 hours of steeping, the kernels were dewatered and washed with water.

#### Grinding and Separating

A mixture of 1:1 kernels to water in a weight ratio was prepared and added to a Waring blender equipped with a dull blade. The Waring blender was put on grind for one minute to mill the starch. The resulting mash was poured onto a 40 mesh screen and what passed through the 40 mesh screen was passed through a 200 mesh screen and subsequently through a 325 mesh screen. The resulting filtrate contained starch and protein. That which did not pass through the first 40 mesh screen was put back into the Waring blender with water in a 1:1 weight ratio. This time a sharp blade was used and the Waring blender was set for one minute on grind. The resulting mash was then subject to a 40 mesh screen and then the filtrate was subjected to a 200 mesh screen and finally to a 325 mesh screen. The final filtrate from both the dull blade grind and the sharp blade grind were dewatered and contained starch and protein. The starch and protein were reslurried and subjected to three separate centrifuges to remove the starch from the protein.

The final starch was then filtered and dried in an oven at 110° C. overnight to a moisture content of approximately 10%.

In this manner, starch was extracted from corn kernels in the lab.

The percent protein was determined by a standard Corn Refiners Association (CRA) method (Kjeldahl method).

The percent oil was also done using a standard CRA method by extracting the oil from dry, ground kernels using carbon tetrachloride for sixteen hours.

The percent amylose was determined using standard colorimetric iodine procedures wherein the starch is first gelatinized with sodium hydroxide and then reacted with an iodine solution and the resulting sample measured using a spectrophotometer in a 1 cm cell at 600 nm against a blank of 2% iodine solution.

The DSC gelatinization temperature was measured using a scanning calorimeter manufactured by Mettler Model No. 300 using a 30% solid starch following the procedure outlined in the owner's manual for that model.

Two Brabender amylograms were run; one in a non-acid environment and one in an acid environment. Both were run at 12% solids using a 90 gram sample with 125

gram cartridge at 100 RPM. The exact procedure used is outlined in the Amylograph Handbook of the American Association of Cereal Chemists, 1982 edition at pages 17 and 18. The respective paddle for the 90 gram cup was used. The difference between the acid and the regular Brabender was that 1.56 grams of glacial acetic acid was added to the sample to drop the pH of the sample to about 3 prior to running of the samples. Such acid test is used to show stability in acid conditions. No acid Brabender was run for Sample A above.

The initial rise was the temperature at which the pen moves away from the baseline.

Both acid and regular samples were subjected to identical heat profiles. The sample started at room temperature and the rapid head mode of the instrument was used to heat the sample to 50° C. Once 50° C. was reached the instrument was set at a controlled rate of heating, 1½° C./minute, until a temperature of 95° C. was reached. The sample was then held at 95° C. for 30 minutes. During this period of heating, the highest viscosity obtained by the sample was labeled Heating Peak. The Heating Final was the last viscosity obtained by the sample at the end of the heating cycle. Next, the sample was cooled at 1½° C. to a temperature of 50° C. The sample was then held at 50° C. for 30 minutes. The largest viscosity measurement taken during this cooling cycle was the Cooling Peak and the final viscosity at the end of the cooling cycle was the Cooling Final.

Brabender curves are a well known tool for determining characteristics of starch.

Brookfield viscosities, another well known measurement used for analysing starch was measured for the starch of the present invention in Table I above. In order to run this test, the starch slurry as it came from the regular, non-acid Brabender test was used for the Brookfield test.

A Brookfield viscometer Model RV was used following standard procedures to obtain these values. The tests were run at 50° C. with each RPM being run for a twenty second one minute time interval.

Hercules viscosities were run on a Kalc Model No. 244RC (manufactured August 31, 1975) following the procedure outlined in the operators manual. Each test was run at 75° F. using bob A. A 25 gram sample of starch paste as obtained from the acid Brabender was used for this test. Hercules viscosities measured high shear resistance of starch in an acid environment. Since Sample A had no acid Brabender run on it, this test was run on a 5.5% paste as obtained after a regular Brabender amylograph.

### EXAMPLE 2

This example illustrates the high amylose content and low gelatinization temperature of the present invention compared to conventional high amylose starches. The results of this example are listed in Table II below:

TABLE II

Starch Samples	% Amylose	Gelatinization Temperature °C.
1. AMY V	58.0	78.6
2. AMY VII	69.7	80.0
3. Native aedu (Sample A)	51.0	69.1
4. Native aedu (Sample B)	53.0	69.5

AMY V and AMY VII are commercial products sold by American Maize-Products Company, Hammond, Ind. and are sold as high amylose starches. The % amylose and gelatinization temperature are mean values

determined from a random sampling of product. The 99% confidence interval for the % amylose in AMY V and AMY VII respectively was 53.4 to 62.5 and 65.5 to 73.8. The 99% confidence interval for the gelatinization temperature for the AMY V and AMY VII respectively was 72.8 to 84.4 and 83.1 to 90.8. Both AMY V and AMY VII were grown in native maize. Starch Samples 3 and 4 correspond to Samples A and B of Example 1 above.

The percent amylose and gelatinization temperatures were obtained using the methods in Example 1 above.

It is readily apparent from Table II above that the starch of the present invention has a high amylose content, above about 50%, while also having a low gelatinization temperature, about 70° C.

It is also clear from Table II above that the starch of the present invention has a gelatinization temperature 5° C. less than high amylose starches with comparable amylose contents.

### EXAMPLE 3

This example illustrates the synergistic nature of the starch of the present invention. The results of this example are listed in Table III below.

TABLE III

Starch Samples	% Amylose	Gelatinization Temperature °C.
1. Native, common maize	27.6	70.8
2. Native, ae grown in OHIO 42	70.5	81.6
3. Native, ae grown in W64A	68.0	84.7
4. Native, du grown in OHIO 42	33.2	72.3
5. Native, du grown in W64A	38.8	72.5
6. Native, aedu grown in OHIO 42	51.0	69.1
7. Native, aedu grown in hybrid cross of OHIO 42 and W64A	53.0	69.5

Sample 1 was a commercial product sold by American Maize-Products Company, Hammond, Ind. Both the percent amylose and the gelatinization temperature for Sample 1 in Table III above are mean values determined from a random sampling of product. The 99% confidence interval for the percent amylose and gelatinization temperature for Sample 1 were 25.9 to 29.3 and 68.7 to 72.7 respectively.

OHIO 42 and W64A have been identified in Example 1 above as type of common corn.

Samples 6 and 7 correspond to Samples A and B respectively of Example 1 above.

The starch in Samples 2-7 were extracted from corn kernels following the procedure outline in Example 1 above.

The method for determining both the percent amylose and the gelatinization temperature was that outlined in Example 1 above.

It is apparent that the starch of the present invention the amylose content equal to about the average for the individual parents i.e. ae grown in OHIO 42 plus du grown in OHIO 42 divided by two equals  $(70.5 + 33.2) \div 2 = 51.85$  while exhibiting a gelatinization temperature lower than either of the individual parents i.e.  $69.1 < 81.6$  or  $72.3$ . Such is truly synergistic.

### EXAMPLE 4

This example illustrates gel strengths of a sol made from starch of the present invention compared to a sol made from a conventional high amylose starch. The results of this testing is reported in Table IV below.



TABLE IV

	Sample B (Example 1)	AMY V
Percent Amylose	53.0%	57.0%
Gel Strength	Did not break	Did not break

In order to perform the gel strength test reported in Table IV above, gels were prepared by mixing water with starch and subjecting the slurry to a non-acid Brabender and subsequently to a non-acid Brookfield viscosity test in accordance with Example 1 above. Both sols were made up at 12% by weight solids. Portions of these sols were added separately to 4 ounce jars into which a plunger was placed. The sols were then allowed to stand at ambient conditions for 24 hours. Gel strength was measured by determining the force needed to remove the plunger from the gel. In both cases, the plunger did not pull out of the gel but rather the plunger and gelatinized gel were pulled out of the 4 ounce jar together.

This example illustrates that the gel strength of a sol made in accordance with the present invention is comparable to a conventional high amylose starch sol.

## EXAMPLE 5

This example illustrates the thin-thick attributes of the starch of the present invention.

The general attributes of a commercial thin-thick starch as shown by a non-acid Brabender amylogram run in accordance with Example 1 above at 5.5% solids shows a rise of not more than 300 BU during the addition of heat to the sample, a slow rise of viscosity during the hold at 95° C. cycle and continued gradual rise during the full cooling cycle. A gentle rise is about 10 BU per minute for the amylogram run in accordance with Example 1 above.

FIG. 1 illustrates the general amylogram for Sample B of Example 1. This amylogram was run in accordance with Example 1.

It is readily apparent that the starch of the present invention has an amylogram similar to that of thin-thick starch.

## EXAMPLE 6

This example illustrates preparing a thickener composition in accordance with the present invention.

The starch of the present invention as extracted in Example 1 above is mixed with water in an amount to produce a slurry having 10% by weight starch. The slurry is cooked at about 90° C. for ten minutes to produce a thickener composition.

## EXAMPLE 7

This example illustrates making a gum candy using the starch of the present invention.

The following ingredients and procedure is used:

TABLE V

Ingredients	% by Weight Present Invention
44/62 csu	56.34
Sugar, fine granular	25.45
Water	7.73
90 Thin-Boiled Starch	7.20
Present Invention Starch	3.13
Citric Acid	0.07
Sodium Citrate	0.08

Procedure

All ingredients are mixed and then cooked to 340° F. using conventional equipment such as a jet cooker. The cooked slurry is then poured into candy molds and allowed to solidify into a gum candy.

## EXAMPLE 8

This example illustrates using the starch of the present invention for retort canning.

A medium is prepared by mixing 6% starch of the present invention with 90% water, 1% salt and 3% sugar. The pH of the system is adjusted to neutral, pH 6.5, with vinegar as needed. This medium is then mixed with foodstuffs, mixed vegetables. The final mixture contains about 50-60% by weight mixed vegetables. The final mixture is placed in a can and sealed. The sealed can is then subjected to retort conditions.

## EXAMPLE 9

This example illustrates chemically modifying the starch of the present invention for use in canning. The chemical modification is esterification.

First a slurry is made up by mixing starch of the present invention with water to form a slurry containing starch in an amount of 35% by weight. To this slurry sodium hydroxide and acetic anhydride are added concurrently. The sodium hydroxide is added in an amount sufficient to bring the pH of the slurry to 8 while the acetic anhydride is added in an amount sufficient to obtain a 2% substitution on the starch. During the reaction, the temperature of the reaction vessel is maintained at 85° F. and under constant stirring. Once the 2% substitution has been obtained, approximately 2 hours, the pH of the slurry is dropped to 5 using a mineral acid. Subsequently the chemically modified starch is washed, dewatered and dried in a conventional manner.

In this manner esterification with acetic anhydride to obtain a 2% substitution of the starch of the present invention is obtained.

Although the use of the present invention has been disclosed primarily with respect to foods, this is not deemed to limit the scope of this invention. The present invention can be used in other fields of industry such as paints, plastics, paper, wallboards.

It will be understood that the claims are intended to cover all changes and modifications of the preferred embodiments of the invention herein chosen for the purposes of illustration which do not constitute a departure from the spirit and scope of the invention.

What is claimed is:

1. A thickened foodstuff for canning comprising a foodstuff, water and having as an essential ingredient therein an effective amount of a natural thin-thick starch, said starch extracted from a starch bearing plant having an amylose extender dull genotype, said starch providing no effective thickening characteristics to said foodstuff before canning while providing effective thickening characteristics to said foodstuff after canning.

2. The thickened foodstuff of claim 1 wherein the starch bearing plant is maize and the starch is extracted from kernels of maize.

3. The thickened foodstuff of claim 1 wherein the amount of starch present is about 1% to about 20% by weight based on total weight of thickened foodstuff.

4. The thickened foodstuff of claim 3 wherein the starch bearing plant is maize and the starch is extracted from kernels of maize.

13

5. The method of claim 1 wherein the water and starch are combined together first and then subsequently combined with the foodstuff.

6. The method of claim 1 wherein the amount of starch added is about 1% to about 20% by weight based on total weight of foodstuff.

7. A method for making a thickened foodstuff comprising combining a foodstuff, water and an effective amount of a natural thin-thick starch, said starch extracted from a starch bearing plant having an amylose extender dull genotype and subjecting said combination to a canning process whereby said starch provides no effective thickening characteristics to said foodstuff

14

before scanning while providing effective thickening characteristics to said foodstuff after canning.

8. The method of claim 7 wherein the starch is extracted from a maize kernel.

9. The starch of claim 8 in granular form.

10. In a method of canning comprising combining a foodstuff, a starch and water, and subjecting the combination to a sterilization process, the improvement comprising the an effective amount of substantially pure starch extracted from a starch bearing plant having an amylose extender dull genotype.

\* \* \* \* \*

15

20

25

30

35

40

45

50

55

60

65

UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 4,790,997

DATED : December 13, 1988

INVENTOR(S) : Robert B. Friedman et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 13, line 1, change the dependency from  
"claim 1" to --claim 7--.

Column 13, line 4, change the dependency from  
"claim 1" to --claim 8--.

Column 14, line 1, change "scanning" to --canning--.

Column 14, line 10, after "the" insert --step of  
employing--.

**Signed and Sealed this  
Ninth Day of May, 1989**

*Attest:*

DONALD J. QUIGG

*Attesting Officer*

*Commissioner of Patents and Trademarks*

## EXHIBIT 15

# United States Patent [19]

Friedman et al.

[11] Patent Number: 4,792,458

[45] Date of Patent: Dec. 20, 1988

[54] FOOD STUFFS CONTAINING STARCH OF A DULL SUGARY-2 GENOTYPE

[75] Inventors: Robert B. Friedman, Chicago, Ill.;  
David J. Gottneid, Griffith, Ind.;  
Eugene J. Faron, Schererville, Ind.;  
Frank J. Pustek, Munster, Ind.;  
Frances R. Katz, Crown Point, Ind.

[73] Assignee: American Maize-Products Company,  
Stamford, Conn.

[21] Appl. No.: 69,260

[22] Filed: Jul. 2, 1987

[51] Int. Cl.<sup>4</sup> ..... A23L 1/04; A23L 1/195

[52] U.S. Cl. .... 426/578; 426/397;  
426/407

[58] Field of Search ..... 426/589, 578, 579, 658,  
426/549, 293-295; 127/29, 32; 536/102

[56] References Cited

## U.S. PATENT DOCUMENTS

4,107,338 8/1978 Tutor et al. .... 426/549  
4,428,972 1/1984 Wurzburg ..... 426/578

## OTHER PUBLICATIONS

CA 94(21) 170 612j. Liu T.T. 1981.  
CA 93(S) 41737j Soberalske 1980.  
CA 92 (13) 107518b Garwood 1980.  
CA 85 (13) 92388p Garwood p. 176.  
CA 91 (21) 171713t Gentinetta et al. 1979.  
BA 78 19313, 84 282833 Biosis.  
Genetics and Physiology of Starch Development—  
Chapter III—Jack C. Shannon and Douglas L. Gar-  
wood pp. 25-85.  
Cereal Science Today—vol. 13—No. 3—Mar. 1968—

Genetic Variations in Maize—RM. M. Sandstedt et al.,  
pp. 82-94.

"Carbohydrate Synthesis in Maize"—Roy G. Creech—pp. 275-322—Pennsylvania State University.

Starch/Starke 33 (1981) Nr. 1, S.9-13—"Some Structural Characteristics of Starches of Maize Having a Specific Genetic Background"—Y. Ikawa et al.

"Genetic Control of Carbohydrate Synthesis in Maize Endosperm"—Roy G. Creech—Dept. of Horticulture, Pennsylvania State University—pp. 1175-1186.

Cereal Chemistry—vol. 39, Nos. 1-6—Jan.—Nov. 1962—Digestibility of High-Amylose Corn Starches Compared to that of Other Starches, the Apparent Effect of the ae Gene on Susceptibility to Amylase Action—Sandstedt et al.—pp. 123-131.

Agron. J.—vol. 50 (1958)—Gene Interactions in Maize Affecting Endosperm Properties—H. Kramer et al.—pp. 207-210.

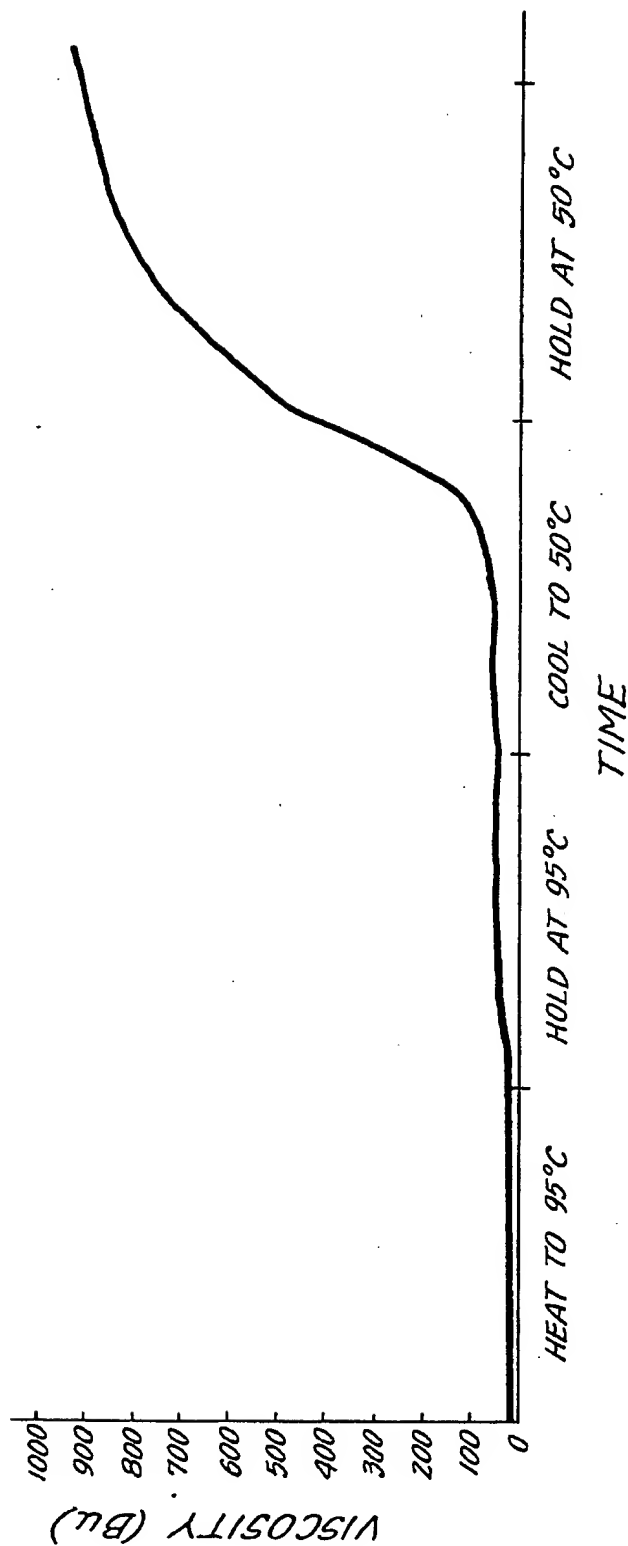
Primary Examiner—Jeanette Hunter

Attorney, Agent, or Firm—Lucas & Just

[57] ABSTRACT

A substantially pure starch extracted from a starch bearing plant having a dull sugary-2 genotype is disclosed. Maize is the preferred plant. The starch exhibits a high amylose content with a gelatinization temperature at least 10° C. below that of conventional high amylose starch with comparable amylose content. The starch also exhibits thin-thick canning starch attributes. A sol and foodstuff containing the starch are also disclosed.

9 Claims, 1 Drawing Sheet



## FOOD STUFFS CONTAINING STARCH OF A DULL SUGARY-2 GENOTYPE

This invention relates to starch and more particularly to starch which has been extracted from a plant having a dull sugary-2 (dusu2) homozygous genotype.

Starch occurs in a variety of plants and is generally categorized based on its plant source. For example, cereal starches are extracted from cereal grains such as maize, rice, wheat, barley, oats and sorghum; tuber and root starches are extracted from plants such as potato, sweet potato, arrowroot, yams and cassava; and waxy starches are extracted from plants such as waxy maize, waxy rice, waxy barley and waxy sorghum.

Generally, starch is comprised of two polymers, amylose and amylopectin which are intertwined to form a starch granule. Amylose is a linear polymer of alpha 1-4 bonded anhydroglucose units while amylopectin is a branched polymer comprised of linear chains of alpha 1-4 linked anhydroglucose units with branches resulting from alpha 1-6 linkages between the linear chains.

Each starch bearing plant produces different percentages of amylose and amylopectin, different size granules and different polymeric weights for both the amylose and amylopectin. These differences produce markedly different properties in the starch.

Heretofore, the only way to affect the properties of starch was to physically and/or chemically treat the starch.

It has recently been discovered that there exists a number of recessive mutant genes in starch bearing plants which have an affect on the properties of starch and that by controlled breeding these mutant genes can be expressed.

Some of the mutant genes which have been identified in maize include the genotypes: waxy (wx), amylose extender (ae), dull (du), horny (h), shrunken (sh), brittle (bt), floury (fl), opaque (o), and sugary (su). Nomenclature for some of these mutant genes is based in part on the effect these mutant genes have on the physical appearance, phenotype, of the kernel. It is also known that within these genotypes there are genes which produce starches with markedly different functional properties even though the phenotypes are the same. Such subspecies have generally been given a number after the named genotype, for example, sugary-1 (su1) and sugary-2 (su2).

One combination of these mutant genes which has been found to possess utility is taught in U.S. Pat. No. 4,428,972 issued Jan. 31, 1984 to Wurzburg et al.

It has now been discovered that a plant having a dull sugary-2 (dusu2) homozygous genotype will produce a starch having a gelatinization temperature significantly lower than conventional high amylose starches having comparable amylose content. Specifically, it has been discovered that the starch of the present invention has a gelatinization temperature about 10° C. lower than that of comparable high amylose starch.

It has also been discovered quite unexpectedly that the novel starch of the present invention possesses thin-thick attributes comparable to chemically modified starches used in canning.

FIG. 1 illustrates an amylogram of the starch of the present invention.

Conventional high amylose starches, amylose content equal to or greater than 50%, have a high gelatinization temperature, above about 80° C. Such a high gelatiniza-

tion temperature increases the processing costs associated with conventional high amylose starch.

The discovery of a high amylose starch with a gelatinization temperature below that of conventional high amylose starch yields a cost savings. Such high amylose starches are especially useful in foods, paper manufacture and fiberglass sizing.

One area of chemically modified starches that has received a great deal of attention is the area of canning starches or thin-thick starches. These starches have a specific utility in canning processes in which high temperatures are attained rapidly and maintained for sterilization of a foodstuff. The starch is typically added to the foodstuff to provide viscosity to the foodstuff. The name thin-thick is given to these starches because of their viscosity behavior, low or thin viscosity initially to allow rapid heat penetration to facilitate sterilization, increased or thick viscosity after sterilization to add body to the canned foodstuff. The term canning as used in the specification and claims means the act of preserving by heat whether the heat is applied before or after the packaging of the food and regardless of the form of the package. Canning includes, for example, pouch packaging, canning, aseptic pack, and retorting. Generally, thin-thick starches are chemically modified such as by hydroxypropylated to a specific degree of substitution and then crosslinked to a specific level. A thin-thick starch specifically developed for retorting is taught in U.S. Pat. No. 4,120,983 issued Oct. 17, 1978 to del Valle et al. The starch taught by the '983 patent is a hydroxypropylated, epichlorohydrin crosslinked tapioca and corn starch derivative.

The discovery that the starch of the present invention can replace these so-called thin-thick chemically modified starches provide economic advantages.

In order to obtain substantially pure starch in accordance with the present invention a plant which produces edible starch and has a dull (du) genotype is crossed with a plant which produces edible starch and has a sugary-2 (su2) genotype to produce a plant having a dull sugary-2 (dusu2) homozygous genotype. The starch is then extracted from this plant. Both the cross-breeding step and the extraction step of the present invention are carried out in a conventional manner.

In order to prepare a sol in accordance with the present invention, a slurry is prepared which comprises water and an effective amount of starch extracted from a plant of the dusu2 genotype and the slurry subjected to a cooking step. The slurry is cooked as necessary to provide a thickener composition which exhibits thickening characteristics comparable to sols made from conventional high amylose starches. If the starch has been made "cold water swellable", then the cooking step can be eliminated. The preferred amount of starch used in the slurry constitutes about 1 to about 20% by weight of slurry. Generally, cooking entails raising the temperature of the slurry to above about the gelatinization temperature of the starch and subjecting the starch to enough shear such that the granules rupture and a paste is formed. It is not necessary that all the granules rupture. Conventional high amylose starches are cooked with special equipment such as jet cookers. Using starch of the present invention, such special equipment is not necessary.

A sol or a thickener composition of the starch of the present invention is added to a foodstuff in a conventional manner to provide the benefits of a high amylose starch to the foodstuff.

Alternatively, starch of the present invention is mixed with a foodstuff or a slurry comprising water and starch of the present invention is mixed with foodstuff and the resulting mixture cooked to produce a thickened foodstuff and to provide the benefits of a high amylose starch to the foodstuff.

In order to replace chemically modified or conventional high amylose starches with starch of the present invention, a replacement ratio of about 1:1, conventional starch:present invention starch, may be employed. Larger or smaller amounts of the starch of the present invention may be used to replace the conventional starch.

The starch of the present invention is employed in a thin-thick starch in canning by mixing starch of the present invention, a slurry or a sol containing the same with a foodstuff suitable for canning. Generally water is included in the mixture. Conventionally, the pH of such a mixture is adjusted, subsequently sealed in a container and subjected to a conventional canning process. During such canning process the contents of the container preferably reaches above about 220° F. for a period of about 5 to about 25 minutes thereby sterilizing the contents of the sealed container. The amount of starch of the present invention employed for such a canning process is an effective amount. Preferably the starch of the present invention is employed in an amount between about 1 to about 20% by weight based on the total weight of the container contents. The sol, a slurry or starch of the present invention is conventionally mixed with the foodstuff.

The term starch as used in the specification and claims means not only the substantially pure starch granules as extracted from a starch bearing plant but also grain products of the starch granule such as flour, grit, hominy and meal.

The term dull sugary-2 or (dusu2) genotype as used in the specification and claims means not only the dusu2 homozygous genotype, dudusu2su2, which has been obtained by standard plant breeding techniques but also the dusu2 genotype which has been moved to another portion of the plant genome by translocation, inversion or any other method of chromosome engineering to include variations thereof whereby the disclosed properties of the starch of the present invention are obtained.

The term high amylose starch means starch having about 50% and above amylose based on the total weight of amylose and amylopectin in the starch granules. Conventional cereal starches and tuber and root starches have about 20% amylose, while waxy starches have less than about 1% amylose.

Any plant source which produces edible starch and which can be crossbred to produce a plant having a dusu2 homozygous genotype may be used. It has been found that maize, rice, barley and sorghum have the mutant genes sugary-2 (su2) and that maize, barley and sorghum have the dull (du) mutant gene. Maize is the preferred plant source. The dull gene in maize is reported to be on chromosome 10 while the sugary-2 gene in maize is reported to be located on chromosome 6. The location of such genes is published in the open literature.

Generally, to obtain a starch bearing plant with both double recessive mutants of the du and su2 genotype, a plant of a du mutant is crossed with a plant having a su2 mutant and thereafter inbred to obtain a plant homozygous in dusu2. After the homozygous dusu2 genotype is obtained, standard breeding techniques are used to ob-

tain hybrid vigor. Hybrids are preferred because of their high starch yield compared to inbred lines. The method of crossing plants and of obtaining specific genotypes in the offspring as well as breeding to obtain hybrid vigor is well known.

Extraction of starch from the plant is well known and typically entails a milling process. In accordance with the present invention, a wet milling process is used to advantage to extract the corn starch from the corn kernels. Corn wet milling comprises the steps of steeping and grinding the corn kernel and then separating the starch from the other components of the kernel. Prior to steeping, the kernels are subjected to a cleaning process to remove any debris which may be present. This cleaning process is usually done at the wet milling plant. The kernels are then steeped in a steep tank where the kernels are contacted with a countercurrent flow of water at an elevated temperature of about 120° F. and containing sulfur dioxide in an amount between about 0.1 to about 0.2% by weight water. The kernels are maintained in the steep tank for about 24 to 48 hours. Next, the kernels are dewatered and subject to a first set of attrition type mill.

The first set of mills generally grind and rupture the kernels causing the germ, corn oil, to be released from the rest of the kernel. A typical attrition type mill used in commercial wet milling processes is sold under the brand name Bauer. The released germ is then separated from the other parts of the kernel by centrifugation. Throughout the grinding steps of the wet milling process the kernel and the kernel components are maintained in a slurry of about 40% by weight solids.

The remaining kernel components which include starch, hull, fiber and gluten, are subjected to a second set of attrition type mills such as the Bauer Mill, to further grind the components and separate the hull and fiber from the starch and gluten. Hull and fiber are generally referred to as bran. Washing screens are used to separate the bran from the starch and gluten. The starch and gluten pass through the screens while the bran does not.

Next, the starch is separated from the protein. This step is done either by centrifugation or by a third grind followed by centrifugation. A commercial centrifugation separator suitable for the present process is the Merco centrifugal separator.

The slurry which contains the starch granules is then dewatered and the resulting granules washed with fresh water and dried in a conventional manner preferably to about 12% moisture.

In this manner, the substantially pure starch of the present invention is extracted from a starch bearing plant of the dusu2 genotype.

Alternatively to the drying step, the starch may be left in suspension and subject to further modification.

Modification of the starch may also be performed on the dried starch. Typically, in order to change the physical and/or chemical structure of the starch granule, the starch is subject to any one or more of eight general treatments. These treatments comprise bleaching, thin boiling, acid treatment, enzyme treatment, dextrinization or dry roasting, etherification, esterification, and crosslinking. Starches which have been treated by any one or more of these eight treatments listed above are conventionally referred to as chemically modified starch.

Bleaching, often referred to as oxidation, is a modification which does not appreciably alter the granular



structure of the starch. Oxidation does, however, tend to lighten the color of the granules and reduce the viscosity of the starch paste.

In order to bleach the starch of the present invention, a slurry of starch is prepared of about 5 to about 40% by weight starch. To the slurry sodium hypochlorite is added with about 6% available chlorine (free chlorine) and the slurry is held at about 110° F. for between about 1 to about 20 hours. The slurry is then neutralized with sodium bisulphite and the resulting granules are dewatered, washed and dried in conventional manner.

Such modification makes the starch of the present invention suitable for laundry starch, paper coating and as a textile size.

In order to produce a thin boiled starch of the present invention, a slurry of starch is 5 to about 40% by weight starch. To this slurry, a mineral acid is added and allowed to react with the starch for about 1 to about 100 hours at about 90° to about 120° F. with constant agitation. Such a reaction is done below the gelatinization temperature of the starch. Subsequently, the solution is neutralized, dewatered, washed and dried in conventional manner.

Thin boiling leaves the granules intact and produces a starch product which has a slight reduced viscosity compared to the non-thin boiled starch. If partial or total destruction of the starch granule is sought, the granule may be subjected to acid treatment.

In order to acid treat the starch of the present invention, a slurry of starch about 5 to about 40% by weight starch is prepared. This slurry is reacted with acid, generally a strong acid, at a temperature above gelatinization temperature. Such a procedure is preferably carried out by jet cooking the slurry through a conventional jet cooker with or without acid already in the slurry and then allowing the slurry to react with the acid, adding acid if needed, for a desired period of time or until the desired dextrose equivalent (DE) is reached. The DE is roughly proportional to the length of time for the reaction. Generally, such jet cooking destroys the starch's granular structure.

After acid treatment, the resulting slurry is neutralized, dewatered and dried. Such product may also be subject to conventional carbon treatment and filtration prior to dewatering and drying. Another treatment which degrades the granular structure is enzyme treatment.

In order to enzyme treat the starch of the present invention, a slurry of starch is made up having about 5 to about 40% by weight starch. To this slurry, enzyme is added at the optimum pH and temperature for the enzyme. Some advantage is found by first jet cooking the slurry to open up the starch granules, cooling the slurry to optimum temperature for the enzyme and then adding the enzyme. If the enzyme is jet cook stable then the enzyme can be added to the slurry prior to jet cooking. The slurry may also be treated with acid first to a low DE and then enzyme treated. After enzyme treatment, the product is dewatered and dried. Alternatively, the product may be subject to conventional carbon bleaching and filtration prior to concentration and/or drying.

In order to dextrinize or dry roast the starch of the present invention, acid is added to dry starch granules and the mixture is heated to a temperature of about 250° to about 350° F. for about 3 to about 72 hours. The product, once removed from the heat, is sold as is. The preferred acids are hydrochloric, phosphoric and any

mineral acid. Such a method causes the partial breakdown of the granular structure.

In order to etherify the starch of the present invention, a slurry of starch is made up having about 5 to about 40% by weight starch. The pH of the slurry is adjusted to about 10 to about 12 preferably with sodium hydroxide. Next, an etherification agent such as ethylene oxide or propylene oxide is added to the slurry in an amount of about  $\frac{1}{2}$  to about 25% depending on the desired degree of substitution. The reaction conditions are held for about 5 to about 30 hours at about 70° to about 120° F. The slurry is then neutralized with any known acid, dewatered, washed and dried.

In order to crosslink the starch of the present invention, a slurry of starch is made up of about 5 to about 40% by weight starch. The pH of the slurry is adjusted to about 8 to about 12 preferably with sodium hydroxide. Optionally, a salt may be added to the slurry to affect swelling of the granules. Then the slurry is reacted with a crosslinking agent such as phosphorous oxychloride, trimetaphosphate salt, or epichlorohydrin at about 70° to about 120° F. for about  $\frac{1}{2}$  to about 5 hours. The length of time of the reaction will depend on the amount of crosslinking agent used and the specific crosslinking agent chosen.

In order to esterify the starch of the present invention, a slurry of starch is prepared having about 5 to about 40% by weight starch. The pH of the slurry is then adjusted to about 8 to about 10 and an esterification agent is added to the slurry such as vinyl ester, acetyl halides, acid anhydrides like acetic anhydride, or succinic anhydride. The esterification agent is added slowly while maintaining the pH of the slurry. The reaction is continued for about  $\frac{1}{2}$  to about 5 hours at about 80° to about 120° F. Once the reaction is completed to the desired degree of substitution, the slurry is neutralized, dewatered, washed and dried.

Any combination of these modifications may be employed on starch of the present invention.

It has been found that a sol comprising water and an effective amount of starch extracted from a plant of a *dusu2* genotype exhibits thickening characteristics which makes the sol a good commercial thickener composition. Such thickener compositions are especially useful in foodstuffs.

The sol is prepared by forming a slurry of water and starch of the present invention and subsequently cooking the slurry thereby forming a paste. Preferably, the sol contains the starch of the present invention in the amount of about 1 to about 20% by weight total sol. The slurry is cooked at a temperature of about 90° C. and above to provide thickening characteristics prior to adding to the foodstuff. Cooking time is about 10 minutes. The sol in accordance with the present invention need not be cooked if the starch has already been subjected to a process which makes it cold water swellable. Cooking generally comprises raising the temperature of an aqueous slurry of the starch of the present invention to the gelatinization temperature of the starch and subjecting the starch to shear such that the starch granules rupture and form a paste.

In order to prepare the thickened foodstuff, a sol made in accordance with the present invention is combined with a foodstuff and the composition is cooked to the necessary degree to provide a thickened foodstuff. Conventional mixing is employed to combine the sol with the foodstuff. Cooking of the sol and foodstuff

composition is also carried out in a conventional manner.

Alternatively, starch of the present invention is mixed with the foodstuff or a slurry comprising the starch of the present invention and water is mixed with a foodstuff and the resulting mixture is cooked to the desired degree to obtain a thickened foodstuff. When the starch itself or a slurry containing the starch itself is mixed with a foodstuff, the resulting mixture must be cooked in order to provide a thickened foodstuff. The mixing as well as the cooking is accomplished in a conventional manner. Cooking is carried out at a temperature of about 90° C. and above. Cooking time is about 10 minutes but may vary depending on the amount of foodstuff present and the amount of shear that the mix is subject to during cooking.

Such a thickener composition provides high amylose characteristics, such a good gel strength while lowering the cooking temperature (gelatinization temperature) for the starch as compared to conventional high amylose starches.

To employ the starch of the present invention as a thin-thick canning starch, the starch of the present invention, a slurry or a sol containing the starch of the present invention is mixed with a foodstuff, placed in a sealed container and subjected to a heating process in which the temperature of the container content reaches about 220° F. and is held there for about 5 to about 25 minutes to accomplish sterilization.

These and other aspects of the present invention may be more fully understood with reference to the following examples.

#### EXAMPLE 1

This example illustrates the extraction of the starch of the present invention from a *dsu2* maize kernel produced by conventional crossbreeding and tests the starch to determine its various characteristics. The tests as well below. The extraction process as well as the test procedures followed are outlined following Table I below:

TABLE I

Test	Present Invention	
	Sample A	Sample B
Percent Protein (dry basis)	1.11%	1.43%
Percent Oil (dry basis)	0.06%	1.43%
Percent Amylose (starch basis)	61.8%	59.5%
DSC Gelatinization Temp.	62.5° C.	60.8° C.
<u>Regular Brabender Amylograms</u>		
Initial Rise	94° C.	90° C.
Heating Peak	50 BU	30 BU
Heating Final	50 BU	30 BU
Cooling Peak	1000 BU	545 BU
Cooling Final	1000 BU	545 BU
<u>Acid Brabender Amylograms</u>		
Initial Rise	89° C.	93.5° C.
Heating Peak	100 BU	60 BU
Heating Final	100 BU	60 BU
Cooling Peak	1920 BU	1885 BU
Cooling Final	1920 BU	1885 BU
<u>Brookfield Viscosities (RPMs)</u>		
10	51,500 cps	52,000 cps
20	30,000 cps	33,750 cps
50	15,600 cps	15,400 cps
100	8500 cps	9550 cps
50	15,000 cps	13,400 cps
20	29,000 cps	26,000 cps
10	53,000 cps	50,000 cps
<u>Hercules Viscosity (RPMs)</u>		
550	396.15 cps	298.85 cps
1100	229.02 cps	183.91 cps

TABLE I-continued

Test	Present Invention	
	Sample A	Sample B
1650	174.0 cps	141.52 cps
2200	144.42 cps	113.10 cps
1650	164.72 cps	127.60 cps
1100	187.38 cps	156.15 cps
550	264.1 cps	229.35 cps

#### Crossbreeding

In order to perform the crossbreeding process, typically maize plants having the mutant gene *du* were cross-pollinated with maize plants having the mutant gene *su2*. From the mature ears of some of these plants, kernels having *dsu2* homozygous genotype were produced. Such kernels were used to produce starch in accordance with the present invention and to provide seed for future maize plants of the *dsu2* homozygous genotype.

#### Extraction Process

The following extraction process was used to extract the starch from the kernel. Sample A was grown in a dent corn background, OHIO 48, while Sample B was grown in a dent corn background, W64A.

#### Steeping

Steeping was carried out by adding maize kernels to water having a 0.2% SO<sub>2</sub> content and holding the temperature of the steep water at 50° C. for 48 hours. The steep water was circulated through the steep container. After the 48 hours of steeping, the kernels were dewatered and washed with water.

#### Grinding and Separating

A mixture of 1:1 kernels to water in a weight ratio was prepared and added to a Waring blender equipped with a dull blade. The Waring blender was put on grind for one minute to mill the starch. The resulting mash was poured onto a 40 mesh screen and what passed through the 40 mesh screen was passed through a 200 mesh screen and subsequently through a 325 mesh screen. The resulting filtrate contained starch and protein. That which did not pass through the first 40 mesh screen was put back into the Waring blender with water in a 1:1 weight ratio of kernels to water. This time a sharp blade was used and the Waring blender was set for one minute on grind. The resulting mash was then subject to a 40 mesh screen and then the filtrate was subjected to a 200 mesh screen and finally to a 325 mesh screen. The final filtrate from both the dull blade grind and the sharp blade grind were dewatered and contained starch and protein. The starch and protein were reslurried and subjected to three separate centrifuges to remove the starch from the protein.

The final starch was then filtered and dried in an oven at 110° C. overnight to a moisture content of approximately 10%.

In this manner, starch was extracted from corn kernels in the lab.

The percent protein was determined by a standard Corn Refiners Association (CRA) method (Kjeldahl method).

The percent oil was also done using a standard CRA method by extracting the oil from dry, ground kernels using carbon tetrachloride for sixteen hours.

The percent amylose was determined using standard calorimetric iodine procedures wherein the starch is first gelatinized with sodium hydroxide and then reacted with an iodine solution and the resulting sample measured using a spectrophotometer in a 1 cm cell at 600 nm against a blank of 2% iodine solution.

The DSC gelatinization temperature was measured using a scanning calorimeter manufactured by Mettler Model No. 300 using a 30% solid starch following the procedure outlined in the owner's manual for that model.

Two Brabender amylographs were run; one in a non-acid environment and one in an acid environment. Both were run at 12% solids using a 90 gram sample with 125 gram cartridge at 100 RPM. The exact procedure used is outlined in the Amylograph Handbook of the American Association of Cereal Chemists, 1982 edition at pages 17 and 18. The respective paddle for the 90 gram cup was used. The difference between the acid and the regular Brabender was that 1.56 grams of glacial acetic acid was added to the sample to drop the pH of the sample to about 3 prior to running of the samples. Such acid test is used to show stability in acid conditions.

The initial rise was the temperature at which the pen moves away from the baseline.

Both acid and regular samples were subjected to identical heat profiles. The sample started at room temperature and the rapid heat mode of the instrument was used to heat the sample to 50° C. Once 50° C. was reached, the instrument was set at a controlled rate of heating, 1½° C./minute, until a temperature of 95° C. was reached. The sample was then held at 95° C. for 30 minutes. During this period of heating, the highest viscosity obtained by the sample was labeled Heating Peak. The Heating Final was the last viscosity obtained by the sample at the end of the heating cycle. Next, the sample was cooled at 1½° C. to a temperature of 50° C. The sample was then held at 50° C. for 30 minutes. The largest viscosity measurement taken during this cooling cycle was the Cooling Peak and the final viscosity at the end of the cooling cycle was the Cooling Final.

Brabender curves are a well known tool for determining characteristics of starch.

Brookfield viscosities, another well known measurement used for analysing starch was measured for the starch of the present invention in Table I above. In order to run this test, the starch slurry as it came from the regular, non-acid Brabender test was used for the Brookfield test.

A Brookfield viscometer Model RV was used follow-

ing standard procedures to obtain these values. The tests were run at 50° C. with each RPM being run for a twenty second time interval.

Hercules viscosities were run on a Kaltec Model No. 244RC (manufactured Aug. 31, 1975) following the

procedure outlined in the operators manual. Each test was run at 75° F. using bob A. A 25 gram sample of starch paste as obtained from the acid Brabender was used for this test. Hercules viscosities measured high shear resistance of starch in an acid environment.

#### EXAMPLE 2

This example illustrates the high amylose content, low gelatinization temperature of the present invention compared to conventional high amylose starches in maize. The results of this example are listed in Table II below.

TABLE II

Starch Samples	% Amylose	Gelatinization Temperature °C.
1. Native common maize	27.6	70.8
2. AMY V	58.0	78.6
3. AMY VII	69.7	87.0
4. Native <u>dusu</u> 2 (Sample A)	61.8	62.5
5. Native <u>dusu</u> 2 (Sample B)	59.5	60.8

Sample 1 was a commercial product sold by American Maize-Products Company, Hammond, Ind. The percent amylose and gelatinization temperature are mean values determined from random sampling of the product. The 99% confidence interval for the percent amylose and the gelatinization temperature were 25.9 to 29.3 and 68.7 to 72.9 respectively.

AMY V and AMY VII are commercial high amylose starches sold by American Maize-Products Company, Hammond, Ind. The percent amylose and gelatinization temperature for the AMY V and AMY VII are mean values determined from a random sampling of the product. The 99% confidence interval for the percent amylose in AMY V and AMY VII were 53.4 to 62.5 and 65.5 to 73.8 respectively. The 99% confidence interval for the gelatinization temperature of the AMY V and AMY VII was 72.8 to 84.4 and 83.1 to 90.8 respectively. Both AMY V and AMY VII were grown in native maize.

Samples 4 and 5 correspond to Samples A and B of Example 1 above.

The percent amylose and gelatinization temperature were obtained using the procedure in Example 1 above.

#### EXAMPLE 3

This example illustrates the synergistic nature of the starch of the present invention. The results of this example are listed in TABLE III below.

TABLE III

Starch Samples	% Amylose	Gelatinization Temperature °C.
1. Native common maize	27.6	70.8
2. Native <u>du</u> grown in OHIO 48	33.2	72.3
3. Native <u>du</u> grown in W64A	38.8	72.5
4. Native <u>su</u> 2 grown in OHIO 48	39.5	63.3
5. Native <u>su</u> 2 grown in W64A	42.0	60.8
6. Native <u>dusu</u> 2 grown in OHIO 48	61.8	62.5
7. Native <u>dusu</u> 2 grown in W64A	59.5	60.8

Sample 1 is Sample 1 of Table II above. Samples 6 and 7 are Samples A and B of Example 1 above.

Samples 2-5 were extracted from maize kernels according to the procedure in Example 1 above. The

## 11

procedure in Example 1 was used to determine both percent amylose and gelatinization temperature.

It is readily apparent that the starch of the present invention has a higher amylose content than its individual parents yet has a low gelatinization temperature.

Samples 2 and 3 were extracted from the kernels according to the procedure outlined in Example 1 above. The procedure used to determine the percent amylose and gelatinization temperature of the samples in Table II above was that outlined in Example 1 above.

It is readily apparent that the starch of the present invention has a gelatinization temperature lower than starches with comparable amylose content. It is readily apparent that the starch of the present invention has a gelatinization temperature about 10° C. lower than starch containing comparable percent amylose.

## EXAMPLE 4

This example illustrates the thin-thick attributes of the starch of the present invention.

The general attributes of a commercial thin-thick starch as shown by a non-acid Brabender amylogram run in accordance with Example 1 above at 5.5% solids shows a rise of not more than 300 BU during the addition of heat to the sample, a slow rise of viscosity during the hold at 95° C. cycle and continued gradual rise during the full cooling cycle. A gentle rise is about 10 BU per minute for the amylogram run in accordance with Example 1 above.

FIG. 1 illustrates the general amylogram for Sample B of Example 1. This amylogram was run in accordance with Example 1.

It is readily apparent that the starch of the present invention has an amylogram similar to that of thin-thick starch.

## EXAMPLE 5

This example illustrates preparing a thickener composition in accordance with the present invention.

The starch of the present invention as extracted in Example 1 above is mixed with water in an amount to produce a slurry having 10% by weight starch. The sol has a bland taste. The sol when cooked at about 90° C. for ten minutes produces a thickener composition.

## EXAMPLE 6

This example illustrates the use of the present invention to make imitation mayonnaise. Table IV below illustrates the ingredients which are used and following the table the procedure used to prepare the mayonnaise is outlined.

TABLE IV

Ingredients	% by Weight Present Invention
Water	51.5
Vinegar (5%)	3.0
Starch of Example 1	3.8
Mustard Flour	1.0
Salt	0.7
Oil	35.0
Egg Yolk	4.4
Whole Egg	0.6
	100.0

## Procedure

In order to prepare mayonnaise using starch of the present invention, water, starch and vinegar in the

## 12

amounts listed in Table IV above are mixed to form a slurry. Next, egg yolks, whole eggs and mustard in the amounts listed in Table IV above are blended together and added to the slurry. Next, the oil is slowly mixed into the slurry and mixing continued until an emulsion is formed. This is then touched with phosphoric acid.

## EXAMPLE 7

This example illustrates using the present invention in retort canning.

A medium is prepared by mixing 6% starch of the present invention with 90% water, 1% salt and 30% sugar. The pH of the system is adjusted to neutral, pH 6.5, with vinegar as needed. This medium is then mixed with foodstuffs, mixed vegetables, to obtain a final mixture that contains about 50-60% by weight mixed vegetables. The final mixture is placed in a container and sealed. The sealed container is then subjected to a retort process.

Although the use of the present invention has been disclosed primarily with respect to foods, this is not deemed to limit the scope of this invention. The present invention can be used in other fields of industry such as paints, plastics, paper, wallboards.

It will be understood that the claims are intended to cover all changes and modifications of the preferred embodiments of the invention herein chosen for the purposes of illustration which do not constitute a departure from the spirit and scope of the invention.

What is claimed is:

1. A thickened foodstuff for canning comprising a foodstuff, water and having as an essential ingredient therein an effective amount of a natural thin-thick starch, said starch extracted from a starch bearing plant having a dull sugary-2 genotype, said starch providing no effective thickening characteristics to said foodstuff before canning while providing effective thickening characteristics to said foodstuff after canning.

2. The thickened foodstuff of claim 1 wherein the starch bearing plant is maize and the starch is extracted from kernels of maize.

3. The thickened foodstuff of claim 1 wherein the amount of starch present is about 1% to about 20% by weight based on the total weight of thickened foodstuff.

4. The thickened foodstuff of claim 3 wherein the starch bearing plant is maize and the starch is extracted from kernels of maize.

5. A method for making a thickened foodstuff comprising combining a foodstuff, water and an effective amount of a natural thin-thick starch, said starch extracted from a starch bearing plant having a dull sugary-2 genotype and subjecting said combination to a canning process whereby said starch provides no effective thickening characteristics to said foodstuff before canning while providing effective thickening characteristics to said foodstuff after canning.

6. The method of claim 5 wherein the starch is extracted from a maize kernel.

7. The starch of claim 6 in granular form.

8. The method of claim 5 wherein the water and starch are combined together first and then subsequently combined with the foodstuff.

9. The method of claim 6 wherein the amount of starch added is about 1% to about 20% by weight based on total weight of foodstuff.

\* \* \* \* \*